VOL. IX, No. 2 APRIL, 1936

PROCEEDINGS

OF THE

HAWAIIAN ENTOMOLOGICAL SOCIETY

FOR THE YEAR 1935

HONOLULU, HAWAII

PRICE 75 CENTS

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All correspondence should be addressed to the Secretary, Hawaiian Entomological Society, Honolulu, Hawaii, from whom copies of the Proceedings may be purchased.

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* Honorary Members.

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JANUARY 3, 1935

The 348th regular meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., January 3, 1935, at 2:30 p. m.

Members present: Miss Suehiro, Messrs. Bryan, Ehrhorn, Hadden, Illingworth, Keck, Marlowe, Mason, McBride, Rosa, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

Visitors: Masters Emil A. Freedman, Jr. and George C. Freedman, and Mr. Spencer Tinker.

In the absence of the President, Mr. Ehrhorn presided.

The minutes of the previous meeting were read and approved. The Secretary reported that the auditor had examined and approved the Treasurer's financial report for 1934. The following appointments by the Executive Committee were announced for 1935:

Editor of the Proceedings: Mr. O. H. Swezey
Curator of Collections: Dr. F. X. Williams
Librarian: Mr. J. S. Rosa

Mr. Elwood C. Zimmerman, proposed for Junior Membership at the preceding meeting, was elected by unanimous ballot. Mr. Swezey proposed the name of Mr. Spencer Tinker for Junior membership.

NOTES AND EXHIBITIONS

Aphycus lounsburyi (Howard)—Specimens were exhibited by Mr. Swezey which had issued from *Saissetia oleae* (Bern.) on stems of *Calotropis gigantea* brought in by Mr. Ehrhorn, Dec. 18, 1934. Apparently it is the first record of the occurrence of this

valuable parasite in Hawaii. Besides this parasite several others issued from the same material as follows:

Scutellista cyanea Mots.	Abundant
Aneristus ceroplastae How.	"
Coccophagus sp. ?	"
Marietta carnesi (How.)	3
Aphytis chrysomphali (Mercet)	2

Mr. Swezey called to the members' attention the usefulness of Mr. Timberlake's article "Records of the Introduced and Immigrant Chalcid-Flies of the Hawaiian Islands" (Proc. Haw. Ent. Soc., vol. v, no. 3, pp. 418-449, December 1924).

Litomastix floridana (Ashm.)—Mr. Swezey reported that a good proportion of caterpillars of *Plusia chalcites* which were feeding on squash leaves at Lualualei, Oahu, December 31, were parasitized by Litomastix.

Rhyncogonus simplex Perkins—Specimens of this native curculionid were exhibited by Mr. Swezey, who had collected them on Sida leaves on the Waianae side of Oahu, December 31, 1934. The locality was about 1.4 miles back from the shore, and about 2 miles southeast from Waianae village. The beetles were quite plentiful, 17 being collected in a few minutes (2 of them on Malva) and Mr. Riley, who was along, collected some besides. It is 40 miles or more from the colony of the same species occurring on the flats near Makapuu Head. Mr. Swezey had visited the latter colony the previous day and collected 32 beetles from *Gossypium tomentosum* in about 15 minutes. These beetles are ovipositing freely, and he will attempt rearing to maturity.

Plagithmysus muiri Perkins—Specimens of this longicorn beetle were exhibited by Mr. Swezey. Four had issued from a section of the trunk of a fallen Sideroxylon tree brought in from Haleauau Valley, Oahu, Nov. 13, 1934.

Cryptolucilia caesarion (Meig.)—A specimen of this fly was exhibited by Mr. Swezey, collected by him at Kawela Bay, Oahu, Dec. 16, 1934. It is the first record of its occurrence on Oahu. It

is the fly which he reared from bluish maggots in cowdung at Kapapala Ranch, Hawaii, June 21, 1934.

Murgantia histrionica (Hahn).—Mr. Swezey stated that a homesteader on the Waianae coast reported having had bugs on his cabbages, which, from his description, must have been the harlequin cabbage bug. Apparently this bug has not been recorded on cabbages here, but in the H.S.P.A. collection are 6 of the bugs collected on Chinese cabbage at Ewa Plantation, Jan. 17, 1930, by Mr. Bond, apparently not recorded at that time. The bug was previously found in 1923, infesting *Capparis sandwichiana* on the Ewa coral plain.

Chloridea obsoleta (Fab.)—Mr. Swezey reported the finding of a few caterpillars of this moth on cane leaves where there was an infestation of *Spodoptera mauritia* (Boisd.) which had migrated from grassy roadside, at Waianae Plantation, December 31. Probably the Chloridea caterpillars had similarly migrated from weeds in waste land. When confined on cane leaves in a jar, these caterpillars did not feed, only nibbling a little, but ate amaranth when it was put in later. Small Chloridea caterpillars were recently found common on Malvastrum at Koko Head.

Pyroderces rileyi (Walsm.)—Mr. Swezey reported this moth in the role of a leafminer, its larva having been found feeding in an aloe leaf, and also in Rochea leaf in a greenhouse at the Foster Garden, Dec. 12 and Dec. 28, 1934, respectively. Larvae of this moth are usually scavengers, but in both instances above they fed in the green leaves.

New Fly Records—Dr. Williams mentioned that among a small collection af aquatic and subaquatic Diptera sent to Dr. G. A. K. Marshall of the British Museum for identification, were two new records of Ceratopogoninae identified by Dr. J. W. S. Macfie. One was a new species of *Dasyhelea hawaiiensis* from Hering Valley, Oahu, and the other *Forcipomyia ingrami* Carter, from various points on Oahu and Hawaii. The latter is found also in other tropical regions. The description and record are published in Stylops, iii, pp. 133-134, 1 fig., June, 1934.

Dasyhelea has a long wormlike larva living in wet algae alongside waterfalls, while Forcipomyia breeds in very thin sheets of slow or stationary water, in and about water held by plants, etc.

Canaceoides nudata (Cresson).—Mr. Bryan reported that E. T. Cresson, Jr., in the Transaction of the American Entomological Society, vol. lx, p. 221, 1934, had described a new genus of ephydrid flies, Canaceoides, for *Canace nudata,* which is a little blackish fly found commonly on moist rocks and tidal pools in Hawaii. The species was originally described from California, but has been collected on the beaches of southeastern Oahu, and on Lisiansky and Wake Islands. Cresson thinks that it may be the same as *Procanace panamaensis* Curran from the Canal Zone.

Palmaricoccus pritchardiae Stickney.—Mr. Swezey called attention to the description of this new species of palm scale in U.S.D.A. Technical Bulletin No. 404, pp. 67-72, 1934. It is described from material sent by Mr. Ehrhorn, collected by J. F. Rock on *Pritchardia hardyi* on Molokai in 1919 and by O. H. Swezey on *P. rockiana* on Oahu in 1916.

In the same paper is listed *Palmaricoccus nesiotes* (Laing) from Lord Howe Island, and "on palm", "Macheno", Hawaii 1906 (Kotinsky No. 134), p. 72. (This latter locality is unknown to local entomologists.)

Another new species of palm scale for Hawaii is *Platycoccus tylocephalus,* p. 108 of the same bulletin. This was collected by L. A. Whitney on palm, Honolulu, 1920.

Ammophorus insularis Boh.—The finding of this tenebrionid on Dec. 10, 1934, under stones in a dry section of central Maui (near reservoir, Field C-1, H. C. & S. Co.) was reported by Mr. Van Zwaluwenburg. This is a new island record for the species.

Latrodectus mactans (Fab.).—The presence of the black widow spider in unusual numbers in December on Maui, was reported by Mr. Van Zwaluwenburg. A very dry field in the Kihei district (Maui Agricultural Company) had been plowed and left fallow for about a year. Over about 200 acres of this field the horizontal webs of the spider were very numerous, being spread from clod to clod, and across irregularities of soil. Nearly every

clod turned over revealed male or female Latrodectus, and often both sexes were found in the same hiding place. Mr. Zimmerman mentioned that Dr. S. F. Bailey, of Davis, California, has recently found a new dipterous species which is parasitic on the egg-sacs of the black widow spider.

Notes on Guatemala.—Dr. Williams gave an interesting account of his recent stay in Guatemala, which he has summarized as follows:

An array of fine volcanic peaks confronts you on approaching the Pacific coast of Guatemala. These peaks range from about 8,000 to nearly 13,000 feet high.

Some 30 miles inland from the port of San Jose is the finca or plantation El Salto, in the district of Escuintla. El Salto is situated at about 1,000 feet elevation in a well watered and rather rugged country.

There is a great abundance of insect life here and I am sure one could easily collect 200 or more species of butterflies in a season. Among the attractive insects is a large day-flying swallow-tailed moth (Uraniidae) that alights in wet spots. The open spaces and the shady forests have their particular insects—in the forests are butterflies well-nigh invisible because of their largely transparent wings. We (Mr. Bianchi and I) collected our parasite material to a great extent on weed flowers. Here we noted many chrysomelid beetles, fine skipper butterflies, moths that greatly resembled a certain dark vespoid wasp, Mantispidae in abundance, aculeate Hymenoptera, etc. In digging for larvae in pastures and old corn fields, we sometimes exhumed tiny snakes, bolboceroid beetles, and, of course, as many as 8 or 10 species of scarabaeid grubs. Passalid beetles are very common. A large active spider was common on boulders bordering streams or on those surrounded by water. It ran actively over running water.

Of curious animals noted here were the "cutete" lizards (Basiliscus) that run on their hind legs and dash across the water, the huge *Bufo marinus,* the "chameleon" or Anolis, etc. Vultures, chiefly the black headed species or "zopilote", were extremely common and of almost omnivorous habit.

Of familiar lowland plants were the huge ceiba trees, the palmate-leaved Cecropias of forest clearings, wild Plumeria, etc.

Heliconoids were plentiful, also gingers, thorny legumes and stinging Jatropha and nettle plants.

In the highlands 5-leaved pines made loose forests and were greatly dwarfed at the timber line. So also was the alder. Elderberry plants grew to over 10,000 feet. Labiates were abundant even to 13,000 feet, as also Scrophulariaceae and lupines. Hummingbirds flew with a whistling noise in the pine forests at 12,500 feet.

Insects familiar in temperate U.S.A. were represented here by yellow butterflies (Colias?), the mourning cloak (*Vanessa antiopa*) and others. Salamanders were found in pine forests and in bromeliaceous plants. Vespoid and sphecoid wasps congregated in the bromeliads and under loose bark. Boring the bases of these plants one sometimes found the larva of a weevil.

We passed two nights at altitudes of over 12,000 feet. Here it gets very cold immediately after sunset, and in the early morning frost sparkles on the ground and icicles hang where the afternoon before water was dripping. On all four mountains visited—Pacaya, 8,200 feet, Agua, 12,200 feet, Tahumulco, 13,800 feet, and Atitlan, over 11,000 feet—were species of dahlias, and we sometimes quenched our thirst by using the old stems as straws through which was sucked up the water accumulated among the leaf bases of bromeliads.

One usually starts the ascent of the volcanoes from considerable altitude; for example, the starting point for the Tahumulco climb at over 9,000 feet, is reached by automobile over a very rough road. Tahumulco, near the Mexican border, is regarded as the highest peak in Central America. The ascent of Atitlan was the most difficult, involving a climb of 8,200 feet, much of it over very rough country: pumice and scoriae. The craters of Pacaya and of Atitlan had steam cracks. The craters are all relatively small as compared with those of Hawaii.

An airplane trip of about 75 miles from Guatemala City to Quezaltenango was very scenic, as we passed over the large lakes of Amatitlan and of Atitlan, as well as along the flanks of several volcanoes.

FEBRUARY 7, 1935

The 349th regular meeting of the Society was held at the Experiment Station, H.S.P.A., February 7, 1935, at 2:30 p. m.

Members present: Miss Suehiro, Messrs. Au, Bryan, Ehrhorn, Hadden, Illingworth, Ito, Keck, Marlowe, Mason, McBride, Pemberton, Rosa, Sakimura, Schmidt, Swezey, Tinker, Van Zwaluwenburg, Willard, Williams and Zimmerman.

Visitors: Miss Mabel Chong, Messrs. Tai Hee Hong, F. Darwin Kirschman, Frank Kitamura, George Miller of South Bend, Ind., Donald Murakoshi and Lorrin H. Smith.

In the absence of the President, Mr. Ehrhorn presided.

Mr. Spencer Tinker, whose name had been proposed for Junior membership at the previous meeting, was elected by unanimous ballot.

An invitation was read from the Museum National d'Histoire Naturelle of Paris, to send delegates to its tercentenary celebration to be held June 24 to 29, 1935. The matter was referred to the Secretary with the suggestion that Dr. Perkins be asked to serve as delegate.

A letter from President Carter was read, suggesting, at President Crawford's request, a discussion by the Society of "the scientific aspects of a Mediterranean fruitfly and melon fly control program, funds for which might materialize out of the processing taxes." The President suggested that the matter be referred to a committee for detailed consideration. At the conclusion of considerable discussion a motion made by Dr. McBride was adopted, after being amended to the following final form: That the President appoint a committee of not less than six members, to be headed by himself, to draw up a research program for a project on fruit fly control, this program to be submitted, after consideration by the Society in special meeting, to the committee of the Agricultural Adjustment Administration.

NOTES AND EXHIBITIONS

Egg-parasite of "black widow" spider.—Mr. Zimmerman reported further on the parasitism of egg masses of *Latrodectus mactans* (Fabr.). Dr. S. F. Bailey of the University of California

at Davis lately found a dipterous parasite tentatively determined as a species of the genus Gaurax, family Chloropidae; this is an effective parasite on the egg masses of the spider in the Sacramento Valley. Material is in the hands of Dr. Cole for specific determination. Dr. Bailey writes that a manuscript on the biology of the spider, prepared by Prof. Herms, Miss McIvor and himself, is in the hands of the University's editorial committee.

Nutgrass weevil.—Mr. Zimmerman reported taking an adult of *Athesapeuta cyperi* Marshall on the top of Puu Palikea, in the Waianae range, Oahu, at about 3,000 feet, on Feb. 3rd, 1935. This capture of a lowland insect at such altitude is unusual.

Cyrtorhinus mundulus (Bred.).—Mr. Swezey reported capturing two of this mirid bug on Puu Palikea at an elevation of 3,000 feet on Feb. 3, 1935. This is the introduced bug which is so efficient in the destruction of the eggs of the sugarcane leafhopper. Cane fields were several miles away on either side of the ridge on lowlands below. These bugs may have been carried up by air currents, or possibly they subsisted on eggs of native leafhoppers, as there were several species of these at the place.

Proterhinus xanthoxyli Perkins.—Mr. Swezey exhibited a specimen of this rare species of Proterhinus collected by him in a dead twig of Xanthoxylum on Puu Palikea, Waianae Mountains, Feb. 3, 1935. Three specimens were obtained. The only time that this species was collected previously was on a Xanthoxylum tree at about 2,500 feet on the trail to Mt. Kaala.

Cryptolucilia caesarion (Meig.).—Mr. Swezey exhibited a specimen of this fly captured by him on the ranch at Koko Head, Oahu, Jan. 13, 1935.

Volucella pusilla Macq.—A specimen of this syrphid fly was exhibited by Mr. Swezey who had reared several from maggots found in rotten stems of the Punahou cactus (*Hylocereus undatus*), Jan. 9, 1935.

Palorus ratzeburgi (Wissm.).—Mr. Swezey exhibited two specimens of this tenebrionid beetle which he had collected under rotten bark at a woodpile in the Experiment Station, H.S.P.A.

grounds, Honolulu, Jan. 29, 1935. It has not been previously recorded from Hawaii. In U.S.D.A. Farmers' Bulletin 1260 it is called the "small-eyed flour beetle".

Plagithmysus muiri Perkins.—Mr. Swezey exhibited specimens of this cerambycid beetle reared from a section of Sideroxylon tree brought in by Messrs. Bryan, Zimmerman and himself from Haleauau Valley, Waianae Mountains, Nov. 13, 1934. A portion of a tree was found to have fallen on the trail, and larvae of the beetle were found abundant in and under the bark. The section brought in was 11 inches long and about 6 inches in diameter. The first beetle to mature and issue from it was on Dec. 26. Between that date and Jan. 31, 20 beetles issued. On Jan. 12, 3 larvae were removed and pickled; also one pupa. Later on one pupa was found, but was injured and died. Altogether the total was 27. At this rate there would have been hundreds from the rest of the fallen tree.

Chaetogaedia monticola (Bigot).—Mr. Swezey made the following observation on the development of this tachinid fly: On Jan. 3, in examining a pupa of *Plusia chalcites* which had formed the previous day, a maggot 3 mm. long was observed within the transparent wall at the base of the abdomen. This was observed from day to day as it made a rapid growth, and on Jan. 9 (after 6 days) the puparium was found already formed within the chrysalis. From this the adult fly issued Jan. 26, 17 days within the puparium.

Litomastix floridana (Ashm.).—Mr. Pemberton reported the recovery of this parasite from larvae of *Plusia chalcites* Esp. at Grove Farm Company, Ltd., on Kauai, and at Lihue, Kauai, on Jan. 11, 1935. This is the first record of the occurrence of this insect on Kauai. Mr. Swezey sent living specimens to that island during 1929, 1930, 1931 and 1932.

Scyphophorus acupunctatus Gyll.—Mr. Pemberton reported the finding, in company with Mr. Swezey, of adults and larvae of this weevil in the stems and fleshy leaves of young Agave plants at the residence of Mr. J. W. Waldron, Nuuanu Valley, Honolulu, on Jan. 30, 1935. In a few cases the larvae had been sufficiently

numerous in the stems to kill the plants. Specimens were exhibited of the adult and larvae. This weevil was first observed in Hawaii by Mr. Muir in December, 1918, when a single specimen was collected.

Necrobia rufipes (DeG.).—Mr. Pemberton called attention to the large numbers of copra beetles now infesting the waterfront and adjacent parts of Honolulu, owing to the presence of a copra-laden freight ship at one of the docks. As this ship has been in port over two weeks, quantities of the beetles have left the ship and become scattered over the town, thus causing considerable alarm among residents as to the outcome. Since copra, carcasses of animals and similar food is not available for breeding on a large scale about the city, there is no likelihood of the beetle becoming a nuisance, especially since it has been known in Hawaii for 30 or more years.

Mr. Bryan supplemented these remarks by describing the enormous abundance of the beetle on the ship in question; within a comparatively brief time they had cleaned the carcass of a bird which had died aboard, in this way lightening the burdens of the Museum taxidermist.

Lacon modestus (Boisd.).—An island record for this species which was overlooked in preparing the Check List of the Elateridae of Oceania (Bishop Museum, Occasional Papers, vol. ix, no. 23, 1932) has been noticed by Mr. Swezey in the H.S.P.A. collection. It is a specimen taken by Mr. Swezey in March, 1905, at Puako Plantation on the island of Hawaii, near Kawaihae.

Mr. Sakimura, who recently returned from more than two years in the Orient, where he searched for enemies of pineapple pests, gave a summary of his work. During two summers he shipped to Honolulu from the Tokyo region some 65,000 specimens of *Thripoctenus* sp., a parasite of *Thrips tabaci* Lind. Visits to Formosa and the Japanese mandated islands showed few new enemies of pineapple mealybugs with the possible exception of a coccinellid (*Nephus,* near *bipunctatus*); pineapple mealybugs are comparatively few in Formosa; wilt is present.

FEBRUARY 15, 1935 (Special Meeting)

A special meeting, the 350th gathering of the Society, was held at the Experiment Station, H.S.P.A., February 15, 1935, to consider the recommendations of the committee appointed to consider the possible use of processing tax moneys for further work on Mediterranean and melon fruit flies.

Members present: Miss Suehiro, Messrs. Bryan, Carter, Ehrhorn, Fullaway, Hadden, Illingworth, Ito, Keck, Marlowe, Mason, McBride, Pemberton, Rosa, Sakimura, Schmidt, Smith, Swezey, Tinker, Van Zwaluwenburg, Weinrich, Willard and Williams.

President Carter called the meeting to order and announced that the committee appointed in accordance with the motion passed at the previous meeting consisted of Messrs. Carter (chairman), Fullaway, McBride, Pemberton, Schmidt and Williams. He then read the following report of the committee, which, after spirited discussion, was unanimously adopted by the Society:

REPORT OF COMMITTEE ON FRUIT FLY PROJECT

The committee begs leave to present the following report:

At the first meeting of the Fruit Fly Committee, held Tuesday, February 12, 1935, the various angles from which the problem of control of Mediterranean and Melon fruit flies could be approached were thoroughly canvassed. As a result two sub-committees were formed, one to prepare a working outline for a biological control project and the other to present plans for work along other lines.

The committee as a whole met again on Thursday, February 14, 1935, to consider these outlines. As a result the following program is recommended for the Society's approval:

A. Biological Control:

The natural enemies of the Mediterranean Fruit Fly *Ceratitis capitata* and related fruit flies should be carefully investigated in tropical West and East Africa south of 8 degrees N. Latitude and along the east coast of Brazil. Though *Ceratitis capitata* does not occur in India, similar studies should be also made of allied fruit flies in some tropical portion of this country. All promising parasites and other enemies found in each region should be introduced to Hawaii.

F. Silvestri, in a rapid survey of African fruit flies and their parasites from July, 1912, to March, 1913, recorded some 25 different parasites, mostly from tropical West Africa. As a result of his efforts, three of these were introduced to Hawaii and established. A fourth was successfully introduced by him from Australia at the same time. In a subsequent expedition D. T. Fullaway succeeded in introducing and establishing two more of the West African parasites. It is evident that much is yet to be done.

Silvestri's survey, though fruitful of results, was of necessity hasty and incomplete. Some of the remarks in the report of his work indicate the great need for further study. They suggest the probability that other natural enemies of fruit flies, superior to those already found and introduced, may occur. We quote him briefly as follows:

> "At Aburi (Gold Coast) in the locality where, according to the observations of Armstrong, *Ceratitis capitata* exists, I did not get a single individual from fruits of coffee, of *Eugenia malaccensis,* from guavas, from Anonas, from the fruit of Landolphia or of Passiflora.
>
> "It is worthy of note that while in Nigeria there were some trees of Alberia laden with fruit infested by *Ceratitis anonae,* not one gave *Ceratitis capitata*; and, again, many fruits of *Eugenia uniflora* examined were all uninfested, while on one of the trees belonging to this species I captured two specimens of *Ceratitis capitata.* In Dahomey there was an extraordinary abundance of Chrysobalanus in perfect condition as regards ripeness, but from thousands of fruit I obtained only four individuals of *Ceratitis capitata.*
>
> " . . . these facts . . . seem to be very important, as indicating that in West Africa *Ceratitis capitata* is largely held in check by important inimical factors, which prevent it from becoming numerous enough to be of serious consequence . . . I believe that all of the Hymenopterous parasites I detected attacking other species of Ceratitis and species of Dacus also attack *Ceratitis capitata,* and that very probably the rarity of the latter is due to them; though I do not wish to deny that the species may also have some special parasite which I did not find."

Studies of parasites and other natural enemies of fruit flies in tropical East Africa have not been made, to the best of our knoweldge, though two investigators, Gowdey and Anderson, report the occurrence of *Ceratitis capitata* in this region. Here is a field also rich in possibilities. Silvestri states that in his opinion "it would be very useful to continue the study of *Ceratitis capitata* and other fruit flies in East Africa from Natal to Uganda, since there may be important parasites in that region". It is our belief that investigations in the states of Uganda and Kenya would be sufficient to our purpose in East Africa.

In the vicinity of Bangalore, India, the larval parasite *Syntomosphyrum indicum* is said to occur in Indian species of Bactrocera. This parasite, which enters infested fruit to parasitize the larvae, will attack and develop in the larvae of *Ceratitis capitata,* as demonstrated in South Africa, Western Australia and Italy, where it has been introduced. As it is reported to be a parasite of Bactrocera species in India, its introduction to Hawaii would seem to be of great importance, since we have both Bactrocera and Ceratitis in the Islands. In this case the presence of an alternate host for the parasite might very well enable it to become widely prevalent and easily maintain itself during periods when Ceratitis and its host plants are scarce in any given community. Other natural enemies of fruit flies in India should be investigated. This applies particularly to the melon fly *Bactrocera cucurbitae,* which is considered indigenous to India.

No egg-parasites of fruit flies are known. Efforts should be made in all countries visited to locate these, if such exist.

Predatory insects, especially Staphylinids, which may enter fallen fruit in search of fly maggots, should be studied. Species of the parasitic Staphylinid genus Aleochara, which develop within fly puparia, are known. Such may occur on fruit flies and should be kept in mind.

It is recommended that from four to six trained entomologists be employed for the foreign work, in order that each region may be worked simultaneously. It is believed that the personnel can largely be selected from entomologists already in Hawaii, who are familiar with the problem; some of whom have had previous foreign work in parasitic introductions.

One year of field work is advised. Existing organizations in Hawaii have sufficient facilities and staffs on hand to handle the imported material expeditiously, with some assistance in labor.

It is believed that $50,000 would cover the costs of the work outlined.

B. Artificial Control:

In addition to parasite introduction as a partial control measure, the undertaking of other studies is recommended. Supplementary to the control effected through parasites, artificial measures are practical under many conditions. The development of attractants, repellents and poison baits may be greatly improved through chemical studies on preferred and or highly resistant host fruit varieties. A particular case in point is the wide variation in the resistance of mangoes as shown by Mason, Haw. Ent. Soc. Proc. 7:170. (1932):

Table 1. Fruit Fly Infestation in Mangoes

Variety	Number examined	Number infested	Per cent infestation
Bierbach	18	0	0
Victoria	182	2	1.1
Pirie	121	2	1.6
Smith-Wootten	150	3	2.0
Cowasjee-Patel	37	1	2.7
Whitney	113	4	3.5
No. 9	112	5	4.4
Mullgoa	38	2	5.3
Ehrhorn	214	12	5.6
No. 5	43	3	7.0
Scott-Pirie	53	4	7.5
Wootten	144	11	7.6
Holt	63	5	8.0
Manila	100	14	14.0
Chinese	25	6	24.0
Hawaiian	643	227	35.3
French	85	50	58.8

Many other fruit varieties show similar characteristics. A determination of the factors responsible for susceptibility or resistances may lead to the development of valuable attractants for practical baits and sprays. For a study of these factors the following project is proposed:

PROPOSED OBJECTIVE

The chemist assigned to this project would organize and outline the problem with a view to determining:

(a). Preferred host fruit chemical constituents responsible for attracting the fruit flies and the resulting high oviposition.

(b). To determine the correlation between the chemical constituents and fruit infestation of varieties highly resistant to fruit fly.

(c) The information gained from paragraphs (a) and (b) to be utilized in the development of more potent attractants and repellents.

(d). The compounds developed under paragraph (c) to be checked by entomologists under field and laboratory conditions and methods of practical application developed.

After careful consideration of the personnel and equipment it is estimated that to pursue the project for one year would cost as follows:

Chemist	$ 4,500.00
Chemicals, equipment and miscellaneous supplies	3,500.00
Unskilled labor	2,000.00
Laboratory space	.....
	$10,000.00

The committee would also urge the desirability of close and formal co-operation between federal and territorial agencies in conducting this investigation.

WALTER CARTER, *Chairman.*

In the discussion which preceded the adoption of the committee's recommendations, Mr. Willard made a strong plea for inclusion in the report of a study of sterilization methods which might make possible the exportation of fruits and vegetables. This, he pointed out, would be of greater immediate benefit to island growers than a further reduction of fly infestation by additional parasites, important as he considered the biological control work to be. President Carter explained that this subject, among others, had been carefully considered by the committee, but that their opinion was that considering the limited period during which the proposed funds would be available, more could be accomplished by the projects which had been recommended in the committee's report. It also developed in further discussion that the investigation of the problems involved in produce sterilization is being considered by the Federal Department of Agriculture at the request of President Crawford of the University, with the idea of proposing it as an additional project in the near future.

Mr. Pemberton appealed to the members to support the proposed biological control work, pointing out the considerable accomplishments in parasitic control of fruit flies already attained locally with comparatively insignificant expenditures of time and money. Now, he said, there arises the opportunity to accomplish results on a scale hitherto impossible.

The following resolution to accompany the committee's report to the officials of the Agricultural Adjustment Administration, was unanimously approved:

WHEREAS, the Hawaian Entomological Society believes that the lack of fruit fly control is an important factor operating against successful agriculture in the Hawaiian Islands; that this problem is amenable to solution if vigorously and adequately attacked; that measures leading to this solution which have been considered by the Society are fundamentally sound,

BE IT RESOLVED that the Hawaiian Entomological Society pledges its support to any program which has fruit fly control as its objective and offers the attached program as an earnest of its technical and professional co-operation.

MARCH 7, 1935

The 351st meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., March 7, 1935, at 2:30 p. m.

Members present: Messrs. Au, Bryan, Carter, Ehrhorn, Hadden, Illingworth, Ito, Keck, Marlowe, Mason, McBride, Pemberton, Rosa, Sakimura, Schmidt, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

Visitors: Miss Mabel Chong; Messrs. Frank Kitamura, George Miller and Donald Murakoshi.

President Carter presided. The minutes of the two previous meetings were read and approved. The President called attention to a recently received list of Coccidae from Professor Jorgensen of Brigham Young University, Logan, Utah, offering mounted coccids in exchange for material not in his collection.

NOTES AND EXHIBITIONS

Geocoris punctipes (Say).—Mr. Swezey exhibited a specimen of this bug, collected at Pearl City, Oahu, in Bermuda grass, January 22, 1935. It had been determined by Mr. E. P. Van Duzee.

Athesapeuta cyperi Marshall.—Mr. Swezey exhibited two specimens of this nutgrass weevil which were collected on orchids by Dr. Lyon, one some time in 1934, the other March 5, 1935. These were probably only incidental, or accidental guests of the orchid house.

Coccophagus hawaiiensis Timb.—Mr. Swezey reported having received the determination of male specimens of this parasite which had issued from *Saissetia oleae* (Bern.), December 24, 1934.

Protaenasius sp.—Mr. Swezey reported collecting this mealybug parasite quite abundantly by sweeping on roadside weeds at Wailuku, Maui, February 24, 1935. Apparently it is the first recovery of this parasite on Maui. On Oahu he had reared this parasite in 1934 from *Ferrisia virgata* (Ckl.).

Mangarevan expedition.—Mr. Zimmerman reported that the task of mounting the insect collections of the Mangarevan expedition to the south Pacific in 1934 had about reached completion.

Pacific Entomological Survey.—Mr. Bryan called attention to two recently issued publications of the Bishop Museum, one entitled "Society Island Insects" (Bulletin 113) and the other, the second part of "Marquesan Insects" (Bulletin 114). Both are based on the collections of the Pacific Entomological Survey. Seven of nine proposed publications on the Survey field work have now appeared. Another bulletin of taxonomic papers is in preparation, as well as one summarizing the distribution and relationships of the Marquesan fauna.

Thripoctenus sp.—Dr. Carter reported finding on Kauai a new parasite of the onion thrips, unlike any other Thripoctenus hitherto known here. Although not actually bred from its host, the parasite was found as a living adult in a colony of onion thrips; hence the relationship is strongly implied.

Hyperaspis sp.—Dr. Carter reported bringing to Hawaii with him in January, living specimens of a Brazilian Hyperaspis given him by Dr. Harry Smith of the Riverside laboratory. The species is now breeding in captivity on *Pseudococcus brevipes* (Ckll.).

Dr. Carter discussed some features of his recent trip to the mainland. Among the recent aims in economic entomology is the search for a satisfactory substitute for arsenicals; the problem of arsenical residues has become an acute one of late years. The rearing of a nematode parasitic upon scarabaeid beetles by Dr. Rudolph Glaser at Princeton, was described, and Dr. Carter suggested that a further attempt be made to introduce this parasite into Hawaii. *Neoaplectana glaseri* Steiner was sent to the H.S.P.A. some years ago, but for one reason or another the introduction was unsuccessful at that time. In Florida Dr. Carter found typical mealybug wilt on pineapples, as well as green-spotting; the Red Spanish variety while very susceptible to the latter malady is resistant to wilt. Dr. Carter found evidence of an internal hymenopterous parasite of *Pseudococcus brevipes* in Florida. The sand-fly problem in the eastern part of that state is being met successfully by leaching the salts from tidal mud-flats, the larvae being dependent for development upon a high salt content.

APRIL 4, 1935

The 352nd meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., April 4, 1935, at 2:30 p.m.

Members present: Miss Suehiro; Messrs. Au, Carter, Ehrhorn, Hadden, Illingworth, Keck, Marlowe, Mason, Rosa, Sakimura, Schmidt, Swezey, Tinker, Van Zwaluwenburg, Wilder, Williams and Zimmerman.

Visitors: Miss Mabel Chong and Mr. F. Kitamura.

President Carter presided. The minutes of the preceding meeting were read and approved.

PAPERS

Mr. Swezey presented two papers, one entitled "Miscellaneous Observations on Maui," from which he read extracts, and the other "A Day on Mt. Olympus."

NOTES AND EXHIBITIONS

Adoretus versutus Har.—Dr. Gerrit Wilder, just returned from the South Seas, told of having to give up his plans to spend some months at Tahiti and at Raratonga, due to unusually rough seas in February which made landing impossible. He mentioned the severe depredations on ornamentals in Fiji of a scarabaeid beetle (probably *Adoretus versutus* Har.) similar to the oriental beetle present in Hawaii.

Rhycogonus koebelei Perkins.—Dr. Williams reported finding a specimen of this weevil, while collecting with Mr. Swezey, on the summit of Mt. Olympus about 2400 feet elevation, on March 31. It was found in the central leaves of ieie vine (*Freycinetia arborea*).

Hercothrips femoralis (Reuter).—Mr. Swezey reported for Mr. Whitney that this thrips had been found on orchids in Mr. F. C. Atherton's orchid house in Manoa; and that *Taeniothrips xanthius* (Williams) had been found on orchids at Mr. Anderson's, at Leahi Home, Kaimuki. These are apparently the first records of these two species of thrips occurring on orchids in Honolulu.

Phloeobius gigas horaeus Jordan.—A specimen of this large anthribid beetle was exhibited by Mr. Swezey, who had captured it on dead Hibiscus at his home in Manoa Valley, March 13, 1935. This is the same insect recorded in Proc. Haw. Ent. Soc. V, p. 344, 1924, and VI, p. 250, 1926, from a specimen collected by Mr. Bissell. A second specimen was recorded in the same publication, IX, p. 1, 1935. The present specimen is the third collected in Honolulu.

Trichogramma minutum Riley.—Mr. Swezey reported that on March 11 he had collected 9 eggs of *Herse cingulata* (Fab.) on leaves of *Ipomoea pentaphylla* at Pearl City, and that 26 *Trichogramma minutum* had issued from 3 of the sphingid eggs.

Volucella pusilla Macq.—Specimens of this syrphid fly were exhibited by Mr. Swezey, who had reared them from maggots found in a rotten branch of *Opuntia megacantha* on the top of Punchbowl crater, March 18, 1935. It appears to be the first record of the breeding of this fly from this cactus, but it has been reared previously from *Hylocereus undatus* in Honolulu. Apparently it is a scavenger fly partial to rottten cactus.

Harmolita swezeyi Phil. & Poos.—Mr. Swezey exhibited a specimen of the Bermuda grass stem chalcid collected by him at Pearl City, March 11, 1935, while sweeping on a heavy growth of the grass. He had not taken this insect since 1914. Prior to that it had been collected quite widely on Oahu, Maui, Hawaii and Kauai.

Asterolecanium pustulans (Ckll.).—Mr. Ehrhorn exhibited a branch of fig, collected on March 25, heavily infested with this burrowing scale, and stated that it seemed more prevalent now than at any other time in the past few years.

Thecla echion (L.).—Mr. Keck exhibited an egg-plant fruit in which the larva of this lantana lycaenid was feeding. This is one of the rare instances of this butterfly attacking a food-plant other than the lantana for which it was originally introduced.

Symbionts in a native delphacid.—Mr. Swezey exhibited a freshly prepared slide showing the symbiont, yeastlike organisms, present in the body of the native *Aloha dubautiae* (Kirk.).

MAY 2, 1935

The 353rd meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., May 2, 1935, at 2:30 p.m.

Members present: Miss Suehiro; Messrs. Au, Bianchi, Bryan, Carter, Ehrhorn, Hadden, Illingworth, Ito, Marlowe, Mason, Pemberton, Rosa, Sakimura, Schmidt, Swezey, Van Zwaluwenburg, Weinrich, Wilder, Williams and Zimmerman.

Visitors: Miss Mabel Chong; Messrs. J. Linsley Gressitt, H. D. Kirschman, Frank Kitamura and Donald Murakoshi.

President Carter called the meeting to order. The minutes of the preceding meeting were read and approved. The chair suggested the desirability of inviting the Pacific Slope branches of the national entomological societies to hold their annual summer meetings here at some future date. After discussion Mr. Swezey moved that the secretary be instructed to extend the Society's invitation to the Pacific Slope branch of the American Association of Economic Entomologists and to the Pacific Coast Entomological Society to hold their summer meetings in Honolulu in 1937. Being seconded, the motion was unanimously approved.

PAPERS

Mr. Swezey presented the following paper: "A List of Fruit and Seed-eating Insects in Hawaii."

Mr. Sakimura read a paper: "Host Ranges of Some Hawaiian Thrips (Preliminary Report)".

NOTES AND EXHIBITIONS

Local moths.—Mr. Swezey exhibited a box of moths recently described by Mr. E. Meyrick, most of them species of Hyposmocoma.

Anomalochrysa cognata Perkins.—Mr. Swezey exhibited two specimens of this native lacewing fly caught in Palolo valley, April 14, 1935. Apparently this is the first capture of this species since the original capture by Dr. Perkins in 1896, when he secured the single specimen which was described. It was collected at 3,000 feet in mountains near Honolulu.

Banza unica (Perkins).—A specimen of this rare native grasshopper was exhibited by Mr. Swezey, who captured it in Palolo Crater, April 14, 1935. This was described from a single specimen collected by Dr. Perkins in mountains near Honolulu in 1896. An occasional specimen has been taken since by some of the entomologists.

Geocoris punctipes (Say).—Mr. Swezey reported that Walter Donaghho had collected two specimens of this bug from Ewa coral plain, April 14. The first record since the original specimen collected by Mr. Swezey at Pearl City, Jan. 22, 1935.

Opogona omoscopa (Meyr.)—Mr. Swezey reported having reared two moths from dead bark of *Hibiscadelphus giffardianus* from James Henderson's place at Kilauea, Hawaii, sent in by L. W. Bryan on Feb. 23rd, 1935.

Latrodectes mactans (Fabr.).—Mr. Swezey reported results of observations on eggs of this spider as to parasitism. He had collected 18 egg cocoons at Keahua, Maui, Feb. 25, 1935. Young spiders hatched from all of these during the period from March 1-28. None had parasites. The number hatching from six of these cocoons were respectively 354, 241, 191, 220, 225 and 291, an average of 254. In discussion Mr. Swezey mentioned a parasite of this spider found in Haiti by Dr. H. L. Dozier, and Mr. Zimmerman again mentioned the Chloropid fly parasitizing this species in California, remarking that its introduction to the Islands should be easily accomplished.

Rhyncogonus saltus Perkins.—Mr. Zimmerman reported that on a visit to Kolokole Pass, Waianae Mts., Oahu, in November, 1934, the adults of *Rhyncogonus saltus* Perkins were observed feeding abundantly on the foliage of *Bidens,* and egg masses were not uncommon in the hollows of specially folded leaves. On April 28, 1935, the site of the colony was revisited, but no adult weevils were found. Numerous remains of dead adult beetles were found scattered about the ground beneath *Bidens* plants, and digging revealed the larvae about the root areas of the plants. The larvae were all found within six or seven inches from the surface. The larvae of *Asynonychus godmani* (Crotch) were also found in the

same area in a ratio of 12 *Asynonychus* larvae to 17 *Rhyncogonus* larvae. In November, the adults of *Asynonychus godmani* were also abundant on the foliage of the *Bidens* but were rather scarce in April. The larvae of the introduced elaterid *Monocrepidius exsul* Sharp were found in numbers among the two species of weevil larvae. These wireworms are effective predators, for few weevil larvae were found in the immediate vicinity where a wireworm was working. Surly, these predators must account for the destruction of large numbers of introduced as well as native soil inhabiting grubs.

The larvae of *Rhyncogonus saltus* are similar in size and general appearance to those of *Asynonychus godmani,* but they can immediately be distinguished even by the naked eye. The *Rhyncogonus* have large, conspicuous heavily chitinized, yellowish anal plates which are not found on the larvae of *Asynonychus godmani.*

Adoretus sinicus Burm.—Dr. Illingworth called attention to an apparent increase in damage by this species during the past few weeks. Mr. Swezey pointed out the lack of seasonal studies on this species, and added that its apparent abundance in dry seasons may be due to the fact that the Metarhizium fungus is less effective at such times. Mr. Ehrhorn reported finding Adoretus damage on Impatiens, which he believed to be an unrecorded feeding plant.

Odonata.—Dr. Williams mentioned that while on a collecting trip with Messrs. Swezey and Zimmerman on Mt. Kaala, Waianae range, on April 28, 1935, Odonata (dragonflies and damselflies) were well represented. The following nymphs or larvae of these insects were found:

1. *Anax strenuus* Hagen—Usually in the larger pools; Haleauau stream, eggs in honohono (*Commelina nudiflora* L.).

2. *Nesogonia blackburni* (McLachl.)—Haleauau stream, small stagnant pool; Gunnera spring, 3600 ft.

3. *Megalagrion oceanicum* (McLachl.)—Haleauau stream, under stones, among roots and algae in running water, etc.

4. *Megalagrion calverti* (Perkins)—On dripping wet bank, Gunnera spring.

5. *Megalagrion nigrohamatum* (Blackburn) var. *nigrolineatum* Perk.—Haleauau stream, under stones, stagnant or clear water.

6. *Megalagrion leptodemas* (Perkins)—Haleauau stream, on exposed ledges, submerged leaves, etc.

7. *Megalagrion amaurodytum* (Perkins) race *waianaeanum* Perkins—3,300-4,000 ft. Between leaf bases of *Astelia* and *Freycinetia.*

Thus all these nymphs have usually well defined to very specialized habitats.

The free-swimming Megalagrion have comparatively large leaf-like caudal (swimming) gills; those that crawl more have shorter and narrower gills, while the nymphs at the leaf-bases of plants have these gills thickened and much reduced. According to habitat the food of these carnivorous insects varies to some extent.

The acquisition of such data as the above is a matter of many field trips over an extended period.

Coptotermes formosanus Shiraki.—Dr. Carter exhibited a piece of redwood (sapwood) from a high-pressure water pipe which had been severely damaged by this immigrant termite. The pipe had been buried in the ground. Mr. Ehrhorn told of shorting of electric cables due to this species having eaten its way through the lead sheathing which covered the cable.

Aphididae—Mr. Au exhibited a slide collection of Hawaiian aphids, and also drawings and a slide mount of an unusual species of the subfamily Hormaphinae, collected on Araucaria pine, Kipapa Gulch, south ridge, 1,400 ft. elevation, Feb. 10, 1935. This species was collected on the same host by P. H. Timberlake in 1916 and recorded as an undescribed species.

Itasca trip to the Line islands.—Mr. Bryan gave a very interesting account of the recent trip of the revenue cutter Itasca to Palmyra, Jarvis, Howland, Baker and Swain's islands, illustrating his remarks with excellent pictures. The entomological features of the expedition he reserved for a future date, only mentioning the severe damage to taro leaves at Leone Bay, Tutuila, Samoa, by a sphingid caterpillar and a noctuid larva.

JUNE 6, 1935

The 354th meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., June 6, 1935, at 2:30 p. m.

Members present: Miss Suehiro; Messrs. Au, Bianchi, Bryan, Carter, Chock, Ehrhorn, Fullaway, Hadden, Illingworth, Keck, Marlowe, McBride, Swezey, Van Zwaluwenburg, Wilder and Zimmerman.

President Carter presided. On motion by Mr. Bianchi it was voted that the committee appointed in 1934 to further the compilation of a manual of insect pests of minor Hawaiian crops, consult with President Crawford with a view to preparing such a manual from the information now available. It was felt that the preparation of such a manual might be a proper project for the use of processing tax money by the local committee of the Agricultural Adjustment Administration, of which Mr. Crawford is a member.

On motion by Mr. Zimmerman it was voted that the secretary provide Miss Suehiro with the proper credentials as the Society's delegate to the Sixth International Congress of Entomology, to be held in Madrid in September.

NOTES AND EXHIBITIONS

New host of Ceratitis capitata Wied.—Mr. Marlowe presented the following note: On May 6, 1935, on the grounds of the Hawaii Experiment Station, fruits of the akee tree, *Blighia sapida* Kon., (Sapindaceae), which were open and lying on the ground, were examined for maggots. Larvae of *Ceratitis capitata* were found in the soft staminal-like part of the fruit located above the seed. The fruit, as is shown on the right of the accompanying figure, remains closed until maturity. At maturity the pod opens as is shown on the left, and remains on the tree in this stage for approximately a week. While the fruit is open and on the tree, the adult fruit fly oviposits in the soft white flesh above the hardened black seed. As many as forty larvae, in various instars, have been taken from one fruit.

Entomologists have held *Blighia sapida* for infestation records and their results have been negative. However, the fruits which

were held by these men were not open at the time of collection, so were not infested. During the past month fifty unopened fruits were held and found to be uninfested, while eighty opened fruits, collected from the tree and the ground, yielded 395 third instar fruit fly larvae. From these emerged 245 *C. capitata,* 78 *Diachasma tryoni* Cam., 13 *Opius humilis* Silv. and some *Tetrastichus giffardianus* Silv. A description of *Blighia sapida* is given by N. Taylor in L. H. Bailey's "Standard Cyclopedia of Horticulture," volume I, p. 515.

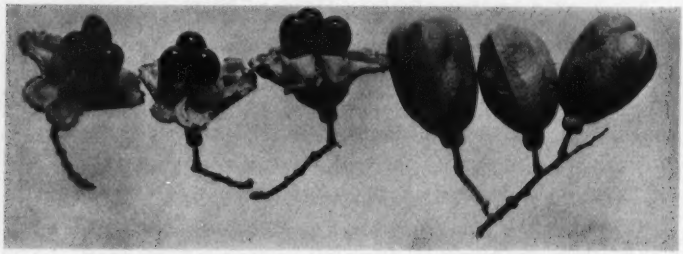

FIGURE 1. Fruits of *Blighia sapida.*

Chalybion caeruleum (Linn.).—Mr. Swezey exhibited one of these blue wasps collected by Phil Weber at Moanalua May 26, where several were obtained. Mr. Weber had also seen the wasp in Manoa Valley at the terminus of the bus line.

Crocidosema plebeiana Z.—Mr. Swezey reported having reared this tortricid moth from seeds of *Abutilon menziesii* and *Abutilon eremitopetalum* collected April 25, 1935, from plants growing in the planting of native forest trees on the grounds of the Kamehameha Girls' School. These are new hosts for this moth, the larvae of which commonly feed on the flower buds of Sida, and have also been reared from seed pods of the weed *Abutilon molle.* It is not a native moth, but occurs in Australia, the West Indies, Central and South America, and has been known in the Hawaiian Islands since 1881. Two adults were reared from the seeds of *A. eremitopetalum* and eight from *A. menziesii*; two parasites, *Microbracon mellitor* (Say), issued from larvae in seeds of *A. menziesii.* This moth is a new host for this parasite.

Argyroploce illepida (Butl.).—Mr. Swezey reported rearing this tortricid from seeds of *Dodonaea viscosa* collected at the same time and place as the preceding species. It is a new host for this moth, which usually infests koa seeds so badly. Five moths issued from a handful of seed capsules.

In some recent collections of koa pods the infestation by this species was as follows: Pupukea, May, 19, 99 percent; Halawa, May 26, 23.5 percent. About a dozen *Pristomerus hawaiiensis* Ashm. issued from the material from Pupukea.

Cremastus flavo-orbitalis (Cam.).—Mr. Swezey reported on the high parasitism of the coconut leaf-roller, *Omiodes blackburni* (Butl.) by this ichneumonid at the present time. He had secured many hundreds of the caterpillars from coconut leaves at Ala Moana Park, May 30. From these, within three days, several hundred Cremastus cocoons were formed. The remaining caterpillars appeared to be nearly all parasitized as shown by dissection of quite a number. The whole lot of parasitized caterpillars and Cremastus cocoons were given to Mr. George L. Windred who was returning to Fiji June 3rd, after a short visit in Honolulu. It is desired to introduce Cremastus into Fiji as a parasite on the banana scab moth, *Nacoleia octosema* Meyrick, which is related to *Omiodes blackburni.*

Brachymeria obscurata (Walker).—Mr. Swezey reported the rearing of this chalcid from cocoons of *Cremastus flavo-orbitalis* (Cam.). From 100 cocoons of *Cremastus* collected from coconut leaves May 14, *Brachymeria* issued May 29-31, after the cocoons had been in the refrigerator for 21 days. Normally *Brachymeria* is parasitic on the pupae of the coconut leafroller, and evidently on account of the *Cremastus* cocoons being more numerous than the *Omiodes* pupae, *Brachymeria* had made use of the former. All adults were smaller than those which issued from the *Omiodes* pupae.

Insect observations on Lanihuli.—Mr. Swezey submitted the following notes for Dr. Williams, who could not be present: Dr. Williams made a trip on June 2nd, 1935, to the rain-guage on the summit of Lanihuli, Koolau range, Oahu, about 2,700 feet high. There were large numbers of the ichneumonid wasp *Ecthromorpha*

fuscator (Fabr.), and the Mexican tachinid fly, *Archytas cirphis* Curran, was also abundant. One or two specimens of the metallic blue and green sphecid wasp (*Chalybion caeruleum* (Linn.)), a recent immigrant, were observed. This insect is now widely distributed on Oahu. Many *Anax junius* Drury dragonflies were coursing back and forth on the summit. Two female *Agrion oahuense* Blackb. were taken. At about the 2,000 foot level two specimens of the fern weevil *Syagrius fulvitarsis* Pasc. were found resting on a large sedge.

Orthezia insignis Dougl.—Mr. Ehrhorn called attention to the prevalence of this scale upon *Coleus* spp., *Hemigraphis colorata, Strobilanthus dyerianus* and the cultivated, dwarf variety of Lantana. He commented upon the current scarcity of the coccinellid *Hyperaspis jocosa* (Muls.), which preys upon the *Orthezia.* Dr. Illingworth stated that he found an oil-pyrethrum spray to be very effective against this pest, not injuring even the tenderest plants.

Comperiella bifasciata How.—Mr. Fullaway reported rearing, for the first time since 1916, this encyrtid from *Chrysomphalus aonidum* (Linn.).

Bufo marinus (Linn.).—Dr. Illingworth reported finding a dozen or more large specimens of this giant toad in his garden at 12th Avenue, Kaimuki. This beneficial toad is rapidly becoming established in various new localities about the city.

Rhynchophorus palmarum (Linn.).—Mr. Bianchi exhibited specimens of this weevil reared from the bole and larger roots of a papaya tree in Guatemala, probably constituting a new host record. Another specimen, which had been given him, was reported to have been taken within a ripe pineapple. A description and full account of the habits of the various stages of this species is given by Blandford in the Kew Bulletin for 1893, pp. 27-60. The list of host plants given there includes *Cocos nucifera, Attalea cohune, Oreodoxa oleracea, Sabal umbraculifera, Acrocomia selerocarpa* and seed pieces of sugarcane.

Mass migration of tenthredinid-larvae.—Mr. Bianchi exhibited a vial of unidentified tenthredinid larvae collected in September,

1934, near the town of Retalhuleu, Guatemala. They formed part of a massed group which was seen one bright morning crawling across a dusty road in a very peculiar manner. The mass was about seven inches in diameter, irregular, but more or less oval in outline, about one inch high in the center and tapering somewhat toward the periphery. It consisted of larvae piled four or five deep. The larvae all faced in the same direction, but as they crawled at obviously unequal rates of speed their relative positions in the group were constantly changing. The outline of the mass, however, changed very slowly, and its thickness evidently not at all. Most remarkable was the manner in which all the larvae, without exception, stopped and resumed their crawling simultaneously; for all the world as if in so doing they followed commands inaudible to the observer. They would move along for about half a minute, stop suddenly to complete inactivity for an equal space of time, and then just as suddenly resume their march again. At each spurt they covered between three and four inches.

This meeting was the last to be attended by Mr. Zimmerman before returning to the mainland for further study. He expressed his enjoyment of his stay in the Islands and his reluctance to leave. He departs with the Aloha of the Society, which hopes to have him return when his college work is concluded.

JULY 11, 1935

The 355th meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., July 11, at 2:30 p. m., with President Carter in the chair.

Members present: Messrs. Au, Bianchi, Bryan, Carter, Chock, Ehrhorn, Fullaway, Illingworth, Ito, Mason, Pemberton, Rosa, Swezey, Van Zwaluwenburg, Weinrich and Williams. The following visitors were present: Master Emil A. Freedman, Jr., Messrs. Neil Macintyre, Robert L. Usinger and Phil Weber.

The minutes of the previous meeting were read and approved.

Mr. Swezey and Mr. Bryan, the committee on the compilation of a handbook of minor crop pests, reported that upon consulting with Pres. Crawford of the local Agricultural Adjustment Administration, they found the prospects of such a handbook being com-

piled under the auspices of the A.A.A. to be very good. In fact among the projects already recommended to Washington by the local officials is one for the study of the insect pests of minor crops, and the Society's suggestion of a handbook fits naturally into such a project. Publication by the University of Hawaii of any manuscript resulting from such study is practically assured.

Mr. Bryan introduced Mr. Robert L. Usinger and nominated him for junior membership.

PAPERS

Mr. Swezey read a paper on "The Insect Fauna of Ieie (*Freycinetia arborea* Gaud.)".

Mr. Van Zwaluwenburg presented a paper entitled "A New Species of Pyrophorus (Coleoptera, fam. Elateridae) from Guatemala, Recently Introduced into Hawaii".

Mr. Fullaway presented a paper on "*Opius fijiensis* n. sp.", a description of an insect which in Fiji is probably parastic in *Dacus passiflorae* Coq.

NOTES AND EXHIBITIONS

Ginger weevil.—Mr. Rosa exhibited specimens of *Pteroporus subtruncatus* Fairm., which he had reared June 21, 1935, in Nuuanu Valley, from upland taro (*Colocasia esculenta*), a new host for this weevil.

Formicaleo perjurus Walk.—Mr. Pemberton exhibited a specimen of this insect which he had collected at the southern border of Hawaiian Commercial & Sugar Co., Maui, on April 19, 1935. This species has not been taken on Maui since 1883, when it was collected by the Rev. T. Blackburn.

Copris incertus var. *prociduus* Say.—Mr. Swezey exhibited some earthen pupal cells of this dung-beetle which were sent for identification by the county extension agent on Maui.

Ceratitis capitata Wied.—Mr. Swezey reported having reared 109 of the Mediterranean fruitfly from eight fruits of a thin-skinned cooking banana. These were from a bunch which grew in his garden. Every banana of the bunch was infested, some of them

having several egg-punctures. The bunch had been left hanging until many of the fruits were already ripe. Perhaps if it had been cut soon enough, so great an infestation would have been avoided. Two *Diachasma tryoni* (Cam.) issued from the above.

Chaetodacus cucurbitae (Coq.).—Mr. Swezey reported a considerable infestation by this fly of the passion fruits on a vine in his garden. A dozen fruits were found infested at one time, which was one-third of the ripe fruits present at the time.

Silversword insects.—Mr. Swezey exhibited the following insects collected from silversword in Haleakala Crater in June, 1935, by Hawaii National Park ranger Sam H. Lamb:

Proterhinus fuscicolor Perk.
Aeschrithmysus terryi Perk.
Nysius coenosulus Stal.
Allograpta obliqua (Say).
Nesoprosopis nivalis Perk.
Odynerus nubicolor Perk.
Tephritis cratericola Grims.
Ilburnia argyroxiphii (Kirk.).
Rhynchephestia rhabdotis Hamps.
Euxoa epicremna (Meyr.).
Small noctuid, not collected previously.
Larvae of dermestid.

Anagyrus nigricornis Timb.—Mr. Swezey reported having reared three of this encyrtid from *Pseudococcus citri* (Risso) on a leaf of a Solanum vine in his garden, June 8, 1935. Also from the same material 14 cecidomyids issued, which may be *Lobodiplosis pseudococci* Felt, introduced from Mexico in 1930 as a parasite of the pineapple mealybug.

Belonuchus ephipiatus (Say).—Mr. Swezey exhibited two specimens of this staphylinid beetle which were collected by Charles Hoyt in rotten papaia trunks on Thurston Avenue, May 21, 1935. It is the first record of this species in Hawaii. It is an immigrant from California, occurring in the southern part of the state, Arizona and Mexico. It was identified from a specimen in

the Giffard collection of California Coleoptera, collected by Dr. Blaisdell at San Diego.

Polistes olivaceus (De G.).—Mr. Swezey reported on the census of a nest of this wasp collected from the eaves of his garage. It seemed to be a large nest for so early in the summer (June 7), and he thought it would be of interest to take a count of the wasps present in all stages. The nest was 3 inches in diameter, and was secured early in the morning when all adults were present. The count was as follows:

57 ♀ 1 ♂	adults clustered on nest.
4 ♀	adults in capped cells.
14 ♀	pupae about mature except for unexpanded wings.
35 ♀	soft pupae.
21	fullgrown larvae in sealed cells.
11	larvae nearly fullgrown in unsealed cells.
16	eggs.
159	total population.

Electric insect trap.—Mr. Swezey called attention to an article in the Pacific Rural Press (issue of June 22, 1935) describing the successful use of an electric trap against the artichoke plume moth.

Lema nigrovittata Guerin.—Mr. Ehrhorn said that the egg-clusters of this chrysomelid beetle laid upon a Datura plant in his yard are removed by some agency at night, and wondered if anyone present knew of an insect which might thus prey upon the eggs. Mr. Swezey suggested that the green lacewing fly larvae might be doing this. Discussion by Messrs. Chock, Ito and Fullaway revealed that adults of Lema have been taken on Oahu from Koko Head on one extreme, to Kunia and even Mokuleia on the other.

Zelus renardii Kol.—Mr. Weber reported that he had seen adults of the assassin bug feeding on the bruchid beetle.

Myzocallis kahawaluokalani Kirk.—Reporting the reappearance of this uncommon aphid, Mr. Au said that on June 22 he

collected 30 specimens of winged and nymphs of the winged form of this species on crepe myrtle, *Lagerstroemia indica,* at a nursery on School Street near the Foster Garden, formerly the old Hillebrand home. The species was described by Kirkaldy in the Proceedings, Vol. 1, p. 101, 1907. Fullaway in his Synopsis of Hawaiian Aphidae (Ann Rpt. Haw. Agr. Expt. Sta., 1910) mentioned the fact that he had never seen specimens of this species. Timberlake in his Notes on Hawaiian Aphidae (Proc. Haw. Ent. Soc., vol. 5, p. 451, 1924) said: "This species has not been found since Kirkaldy's description was published in 1907, and is unknown to me". Through conversation with Mr. Fullaway, Mr. Au learned that about five years ago Mr. Mason also had collected the species.

Aphis swezeyi Fullaway.—Mr. Au reported that specimens of this species, of which Timberlake (l. c., p. 454) wrote: "This species recorded by Fullaway on *Gnaphalium* sp. has not been collected since,", were collected March 27, 1935, by Mr. Ito at Wahiawa, Oahu, on the roots of *Emilia sonchifolia.* Subsequently he took another specimen in a wind trap at Maunaloa, Molokai. On May 17 Dr. Carter also found the same species on *Emilia* roots at Haiku, Maui.

A New Aphid.—Mr. Au exhibited a slide mount of a small dark green aphid with large, irregular, ciliated sensoria, which was blown into the laboratory of the Pineapple Experiment Station by the wind. It is a genus and species apparently new to Hawaii, and fails to "key out" in A. C. Baker's generic classification of the Aphidiae. Specimens have been sent to Dr. O. W. Oestlund of Minnesota, for identification.

Tenebrionid beetles.—Mr. Weber reported finding both *Ammophorus insularis* Boh. and *Blapstinus dilatatus* LeC. extremely abundant under cowdung in the Punahou pasture. Mr. Bryan said that he once saw the former species crawling in great numbers within Diamond Head Crater.

Drasterius dorsalis (Say).—Mr. Van Zwaluwenburg exhibited an elaterid beetle, identified as *D. dorsalis* (Say) var. *comis* (LeConte), which was collected by Mr. Neil Macintyre at Nanakuli

Beach, Oahu, on the evening of June 16, 1935. The insect was taken on food at 8 p. m. on the sandy beach. This is an immigrant hitherto unknown in the Islands; it is widespread in North America from the Atlantic to the Pacific, and from Canada to central Mexico. It is in the Leng Catalogue under *Aeolus,* but properly belongs in *Drasterius. D. livens* (LeConte) is a synonym, and so probably is *comis* (LeConte), which is at best a variety. The larvae are predacious, having been reported by Cartwright (South Carolina Station Bulletin 257, p. 31, 1929) to attack the pupa of the maize billbug, *Calendra maidis* (Chittenden).

Lathridiidae.—Mr. Bryan showed a copy of the first publication of results of the Bishop Museum's Mangarevan expedition. It is by E. C. Zimmerman and is entitled: "A New Lathridiid from Tahiti" (Bishop Museum, Occ. Papers, vol. xi, no. 9, 7 pp., 1 fig., July 6, 1935) and describes *Mumfordia monticola* from 4 specimens on Mt. Aorai trail, Tahiti, 5,500-6,300 feet, on undersides of dead *Freycinetia.* The publication also contains a check list of the Lathridiidae of Polynesia and eastern Melanesia with 13 species enumerated.

AUGUST 1, 1935

The 356th meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., August 1, 1935, at 2:30 p. m. with President Carter in the chair.

Members present: Messrs. Bianchi, Carter, Illingworth, McBride, Rosa, Van Zwaluwenburg and Williams.

Visitors: Master Emil A. Freedman, Jr., and Mr. Hugo T. Cler.

The minutes of the previous meeting were read and approved. Mr. R. L. Usinger was elected to membership in this society.

NOTES AND EXHIBITIONS

Koa seed tortricid in Macadamia nuts.—Dr. Williams mentioned that Macadamia nuts from Kauai had been sent by Mr. C. C. Barnum to the H.S.P.A. Experiment Station for examination. The nuts had been damaged by the Koa seed caterpillar *Argyroploce illepida* (Butl.) (Tortricidae), that fed chiefly in the

outer coat or rind. In two cases, however, a caterpillar had bored through the hard woody shell and eaten of the meat of the nut. A third nut that was undersized and evidently imperfect had been quite destroyed. This seems to be the first record of damage to the meat of the Macadamia nut by this or any other insect.

Flight of Ponera perkinsi Forel.—Dr. Carter reported a mating flight of this ant, at Helemano, Oahu, on July 1, 1935, a bright sunny day. Flight was about 6 feet above the ground, and must have been general, for on the same date mating individuals of the same species were blown into the Pineapple Experiment Station laboratory at the University. This ant is well distributed, but not commonly seen; it is carnivorous, living in the ground.

Ants in Koa galls.—Master Freedman reported finding ants in outgrowths occurring on Koa limbs on Wilhelmina Rise.

SEPTEMBER 5, 1935

The 357th meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., on September 5, 1935, at 2:30 p. m. with President Carter in the chair.

Members present: Messrs. Bianchi, Bryan, Carter, Ehrhorn, Hadden, Illingworth, Keck, Krauss, Mason, McBride, Rosa, Schmidt, Usinger, Van Zwaluwenburg, Weinrich and Williams.

Visitors: Avery S. Hoyt, G. B. Marvin, and Phil Weber.

The President installed Dr. F. X. Williams as Secretary-Treasurer in place of Mr. R. H. Van Zwaluwenburg, who will be away from the Territory for some months.

The minutes of the previous meeting were read and approved.

President Carter introduced Mr. Avery S. Hoyt, Assistant Chief of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C. Mr. Hoyt responded with a brief and interesting talk.

PAPERS

Mr. E. H. Bryan, Jr., read a paper entitled "Lonchoptera in Hawaii".

Mr. R. L. Usinger read a paper on "New Distributional Records of Hawaiian Heteroptera".

NOTES AND EXHIBITIONS

Lagocheirus obsoletus Thoms.—Dr. Illingworth reported as follows on this cerambycid beetle: This beetle has appeared frequently in our notes. It has been bred from Kukui, Araucaria, Plumeria, Alamanda, Euphorbia, Pseudopanax, etc. Recently I found geraniums badly attacked at Kaimuki. The whole stems were bored out and killed, the cavities filled with frass, in which the larvae pupated.

Apomecyna pertigera Thoms.—Dr. Illingworth reported as follows on this cerambycid beetle: This introduced beetle, though present in the Islands for many years, has appeared only twice in our Proceedings. Fullaway reported it from cucumber stems and Swezey found it breeding extensively in a gourd vine. Subsequent to 1912, I have bred it repeatedly from stems of squash, cucumber and pumpkin, but have failed to report it at our meetings. The specimens exhibited are from Kailua, where they proved very destructive to the watermelon crop, boring the stems before the fruit had matured.

Conoderus eveillardi Le Guillou.—Mr. Van Zwaluwenburg reported that specimens of the recent immigrant *Conoderus* have recently been determined as the above species by Dr. H. J. Carter of Wahroonga, New South Wales. Dr. Carter writes: "Your examples are very close to the type of Macleay's *C. rubicundus*, placed as a synonym of *eveillardi*, being more red and less densely hairy on the pronotum than with the fresh examples of *eveillardi*, but it is, I think, only a slight variation of the 'fawn' colored normal form". The species was described from New South Wales, and was first taken in Honolulu at light in Manoa Valley in August, 1931, by Mrs. Van Zwaluwenburg. Subsequent captures were made at Waikiki, Kahala and again in Manoa.

Conoderus sp.—Mr. Phil Weber reported the capture of this elaterid August 22, 1935, at light globe of store near Waialua Fresh Air Camp, 9:30 p. m., weather cool. Legs eaten by ants in camp, due to poor storage facilities.

Vanessa tammeamea Esch.—Mr. Phil Weber reported that on August 5 before the CCC cut the Mt. Tantalus trails, there was a wounded koa tree right above the trail after the third bend, about 50 yards straight up from the Hawaiian Warrior marking Tantalus summit. A friend and he used to go to this tree catching *Vanessa tammeamea,* which drank the sap issuing from the wound. Beneath the tree were approximately 500 wings of *V. tammeamea,* scattered on the grass. His guess was that the butterflies became intoxicated by the sap, which smelt exactly like beer, and fell to the ground, where they were either wet by rain, so as to render them incapable of flight, or were attacked by ants. The sap smelt and tasted exactly like beer. It was white and foamy. The tree is no more, having been taken by the CCC because it overhung the path.

Milichiella lacteipennis (Loew).—Mr. Bryan exhibited three crushed specimens of this phyllomyzid fly which had been captured on board the Pan American Airway's "Oriental Clipper" upon its arrival from Wake and Midway Islands, August 23rd. These three small black flies were the only insects noted by Mr. Fullaway during his inspection of the plane. This species has been previously reported from Midway (Bryan, B. P. Bishop Museum Bull. 31, 1926) but had not been captured on Wake. It is believed that the flies went aboard the Oriental Clipper at Midway Islands.

Megalagrion oahuense (Blackburn).—Dr. Williams reported the discovery of a nymph, wanting about 3 moults to full growth, of this damselfly. It was found in the wet mat of uluhi, or false staghorn fern, (*Gleichenia linearis*), on a ridge back of Manoa Valley, Oahu. This nymph is of the non-swimming type and is rough and thickset with thick almost furry caudal gills. Dr. Williams had been hunting for the early stages of this insect since March, having made 14 trips to the mountains behind Honolulu. He also mentioned the moulting of the giant dragonfly nymph *Anax strenuus.* One specimen that hatched in mid June has to date, September 5, moulted 11 times and is about half grown. The nymphs become very tame when hungry and look up expectantly for food.

Mr. Ehrhorn read an interesting letter from Mr. Swezey from the South Seas.

BOOK REVIEWS

Mr. E. H. Bryan reviewed "Insects of Samoa—Concluded", by Dr. P. A. Buxton.

Mr. R. L. Usinger reviewed "Wigglesworth's Insect Physiology", and "Snodgrass on Insect Morphology".

OCTOBER 3, 1935

The 358th meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., October 3, 1935, at 2:30 p. m., with President Carter in the chair.

Members present: Messrs. Bryan, Carter, Ehrhorn, Hadden, Illingworth, Keck, Rosa, Usinger and Williams.

Visitors: Emil A. Freedman, Jr., Geo. P. Gray, R. E. Green and T. Mitamura.

The minutes of the previous meeting were read and approved.

NOTES AND EXHIBITIONS

Agrilus extraneus Fisher.—On behalf of Mr. Phil Weber, Mr. J. S. Rosa exhibited specimens of this buprestid beetle, described from Oahu. Mr. Weber had taken 17 specimens on a Poinciana stump in Honolulu.

Lacon modestus (Bdv.).—Mr. Rosa exhibited the first rearing here of this elaterid beetle. Two larvae of this insect were secured under a stone in the Koko Head region.

Eopenthes divisus Sharp.—Mr. Usinger spoke of capturing specimens of this elaterid beetle. Apparently it has not been recorded since its original description in 1908. The type series was from Oahu, Honolulu, 2,000 ft., 1896, Perkins. Mr. Usinger beat three specimens from *Metrosideros polymorpha* on the Manoa-Palolo Ridge, Sept. 22, 1935.

He also exhibited some Hemiptera from collections in the University of Hawaii.

Dr. Carter exhibited potted pineapple plants to which, through the use of certain aphids, he had been able to transmit the *Commelina* virus disease.

Mr. Bryan exhibited two boxes and a list of the contained species of aquatic and subaquatic diptera which he had determined for Dr. Williams.

Master Freedman said that upon watering a certain *Coleus* plant in a dish, a hump of quaking dirt was revealed, from which a *Bufo marinus* toad peeped up.

President Carter introduced Mr. Geo. P. Gray, now stationed with the Federal fruit fly laboratory in Honolulu. Mr. Gray responded appropriately.

NOVEMBER 7, 1935

The 359th regular meeting of the Society was held at the Experiment Station, H.S.P.A., November 7, 1935, at 2:30 p. m.

Members present: Messrs. Bryan, Carter, Ehrhorn, Hadden, Illingworth, Keck, Marlowe, Mason, Pemberton, Rosa, Swezey, Usinger and Williams.

Visitors: Messrs. Walter Donaghho, Geo. Gray, Robert E. Green, Charles Hoyt and Donald Starr.

President Carter called the meeting to order. The minutes of the previous meeting were read and approved.

The President, as authorized, reported progress on the matter of inviting the Pacific coast branch of the A.A.A.S. to hold a meeting in Honolulu in the near future.

The matter of a suitable obituary notice for the late Dr. Gerrit Wilder was taken up. Mr. Bryan suggested that a committee of two, composed of Messrs. Ehrhorn and Swezey, be appointed to this end. Approved and appointed by the president.

Mr. O. H. Swezey read an interesting letter from Bro. Mathias Newell, a veteran member of the Hawaiian Entomological Society and now at Dayton, Ohio.

PAPERS

On behalf of Dudley Moulton of California, Mr. Swezey presented a paper entitled "Thysanoptera of the Hawaiian Islands". A box of thrips named by Mr. Moulton was exhibited.

Mr. R. L. Usinger presented a paper entitled "The Genus Geocoris in the Hawaiian Islands".

Mr. E. H. Bryan, Jr., presented a review of C. H. T. Townsend's Manual of Myiology, Pt. II, Sao Paulo, Brazil, 289 pp., 9 pls., 1935.

On behalf of Harold Compere, Dr. Carter presented a paper on "A New Genus and Species of Encyrtidae parasitic in the Pineapple Mealybug, *Pseudococcus brevipes* (Ckll.)".

NOTES AND EXHIBITIONS

Coccinella californica Mann.—Mr. Charles Hoyt exhibited a specimen of this ladybeetle found in Dole's pasture, Honolulu. It has probably become established from a single female found in an apple box in Honolulu years ago by Mr. Swezey, who reared a generation and turned some loose. This is the first recovery since.

Periplaneta brunnea Burm.—Mr. Swezey reported having a letter from Mr. Morgan Hebard in which this name is given for the roach that we have been calling *P. ignota* Shaw. Specimens of the latter had been sent to Mr. Hebard, who states that *ignota* is a synonym of *brunnea*.

Opius anastrephae Vier.—Mr. Mason stated that this parasite on the West Indian fruitfly, *Anastrepha fraterculus* Wied. in Puerto Rico, was introduced into Hawaii on October 22 and 24. Two shipments of adult parasites totaling 490 living insects were received. Attempts at oviposition on larvae of both the Mediterranean fruit-fly (*Ceratitis capitata*) in kamani nuts and on the melon fly (*Chaetodacus cucurbitae*) in cucumbers were observed, when the parasites were placed in cages with the infested fruits. A heavy mortality occured within a few days after arrival and 80 living parasites were liberated October 30 under kamani trees in Queen Emma Park.

Marine midge.—Dr. Williams exhibited male specimens of a midge (Chironomidae) that he had taken on tidepool rocks on the Waianae coast, Oahu, on November 3, 1935. This inconspicuous species resembles in form, at least superficially, and considerably in its activities, flies of Terry's genus *Charadromyia*, that frequent

torrents and rapid flume and ditch water. It is probably a marine species and the first such, as far as known, recorded from the Hawaiian Islands. Marine Chironomidae, however, occur on other islands of the Pacific and at least one species should be expected here.

Australian ants.—Mr. Swezey exhibited a collection of ants he had made while in the Antipodes and mentioned items of interest concerning the scenery and fauna of New Zealand.

Pseudococcus brevipes parasite.—Dr. Carter exhibited a promising chalcidid wasp parasitic on the pineapple mealybug *Pseudococcus brevipes.* It was collected by Sr. Garcia Salas in Columbia.

Check List of Ants of Oceania.—Mr. Bryan exhibited a copy of a "Check List of the Ants of Oceania" by Dr. William Morton Wheeler, just issued by B. P. Bishop Museum as Occasional Papers, vol. XI, no. 11, 1935. In addition to a systematic list of about 560 forms (339 species, 108 subspecies, 113 varieties), with notes on their distribution and place of original description, and a bibliography of 123 papers, there is a general discussion of the distribution of ants in Oceania. Prof. Wheeler assigns the Pacific island ants to four zoogeographical categories: (1) Wide-ranging, or pantropical species of Indian, Malagasy, or Indonesian origin. (2) Wide-ranging paleotropical species, which have not yet succeeded in establishing themselves in the neotropical region. (3) A considerable number of interesting indigenous or precinctive forms, also with Old World affinities, but confined to particular island groups or islands. And (4), A small number of neotropical forms confined to the islands off the coast of South America and Central America, because they have not been able to cross the broad belt of open water to the westward. The only exception is *Brachymyrmex aphidicola,* which has recently succeeded in reaching Honolulu. Examples of restricted or sporadic distribution are given; and methods whereby ants may have invaded Pacific islands are discussed.

Cicadellidae of Hawaii.—Mr. Bryan exhibited also a copy of "Cicadellidae of Hawaii" by Dr. Herbert Osborn, it being B. P. Bishop Museum Bull. 134, 62 pp., 27 figs., Aug. 10, 1935. It con-

tains a list of host plants of the species so far as known; table of distribution on the different islands; keys to subfamilies and genera. Of the 12 genera, 2 are new and there is one new subgenus. Of the 79 species included, 25 are new and there is one new variety. *Nesophrosyne* is the largest genus with 38 old species and 16 new species, and one new variety. In addition, in its subgenus *Nesoreias* there are 2 old and 4 new species. Immigrant species of somewhat recent introduction are: *Draeculacephala mollipes* (Say), *Bythoscopus robustus* (Uhler), *Opsius stactogalus* (Amyot), *Empoasca solana* DeLong.

For each species there is a description, reference to place of description, distribution throughout the islands, and there are illustrations for the new species.

DECEMBER 5, 1935

The 360th regular meeting of the Hawaiian Entomological Society was held at the Experiment Station, H.S.P.A., on December 5, 1935, at 2:30 p. m.

Members present: Miss Suehiro; Messrs. Au, Bryan, Carter, Chapman, Chock, Ehrhorn, Illingworth, Ito, Keck, Marlowe, Mason, McBride, Pemberton, Rosa, Swezey, Usinger and Williams.

Visitor: Master Emil A. Freedman, Jr.

President Carter called the meeting to order.

The minutes of the preceding meeting were read and approved.

An Obituary of Dr. Gerrit P. Wilder was presented by the committee appointed for that purpose: Messrs. E. M. Ehrhorn and O. H. Swezey. It was moved by Mr. E. H. Bryan, Jr., and seconded by Dr. R. N. Chapman that the report of this committee be accepted and that a copy of this report be sent to Mrs. Gerrit Wilder. It was passed.

The Secretary-Treasurer read the financial statement of the Society for the year 1935. The president appointed Mr. J. S. Rosa to audit the Treasurer's books.

The President and others discussed the invitation to the American Association for the Advancement of Science to hold a meeting in Honolulu. As a result, it was moved by Mr. Ehrhorn and sec-

onded by Mr. Marlowe that Mr. O. H. Swezey be appointed to write up an article relative to the varied and interesting aspects of Entomology in the Hawaiian Islands; said article to be presented to the proper official of the above A.A.A.S. Passed.

The Secretary then reported on the results of the Executive Committee Meeting, held just before the present meeting, with nomination as follows: President, C. B. Keck; Vice President, Carl T. Schmidt; Secretary-Treasurer, F. X. Williams; additional members of the Executive Committee, Mr. C. E. Pemberton and Dr. Walter Carter. Mr. Pemberton moved that the rules of the Society be suspended and that the Secretary be instructed to cast the ballot for the above nominees. Seconded and passed and the nominees thus duly elected to office.

President Carter then reappointed Mr. O. H. Swezey as Editor of the Proceedings, Mr. J. S. Rosa as Librarian, and F. X. Williams as Curator of Collections.

PAPERS

Presidential address. Mr. Keck took the chair while Dr. Walter Carter delivered the presidential address entitled "Insects and Plant Diseases".

Dr. F. X. Williams presented a paper entitled "Biological Studies in Hawaiian Water Loving Insects—Part I, Coleoptera or Beetles; Part II, Odonata or Dragonflies".

"Notes on Hawaiian Heteroptera, with Descriptions of New Species" by E. P. Van Duzee; presented by Mr. Swezey.

NOTES AND EXHIBITIONS

Mr. R. L. Usinger spoke of his reecnt trip to Lanai and of the insect conditions there.

Periplaneta brunnea Burm.—Mr. Swezey exhibited a series of 11 adults and 12 nymphs of this roach which were collected by Mr. Ito on Nov. 22, 1935, in the stable at the Wahiawa Branch of the Pineapple Experiment Station. The series shows that the anchor shaped pale spot on the thorax is not a reliable character for separating this species from *americana* as there was considerable vari-

ation. For accurate determination, the structural characters of the supra-anal lamina should be used, for both sexes.

He also exhibited a collection of Hawaiian Hemiptera-Heteroptera worked on by Mr. E. P. Van Duzee, and recently returned.

Mr. Bryan announced the receipt from Wake Island, by the first return trip of the Pan-American Airways plane "China Clipper", of a collection of natural history specimens including insects and spiders. These were collected by Dr. M. L. Kenler and Col. G. W. Bicknell.

Lonchoptera in Hawaii (Diptera)

BY E. H. BRYAN, JR.

(Presented at the meeting of September 5, 1935)

The genus Lonchoptera, family Lonchopteridae (Diptera), contains a few species of rather small, slender, brownish or yellowish flies. These have moderately long legs and long pointed wings which have a peculiar, characteristic venation, said to differ between the sexes, the female having the sixth vein meeting the fifth to form a large closed cell near the hind margin of the wing, while the sixth vein of the male is described as running to the hind margin. Only the female is known in Hawaii.

Specimens of Lonchoptera have been reported as collected in Hawaii as follows:

Hawaii, 29 miles Olaa, August 1922, one specimen, by the late W. M. Giffard.[1]

Molokai, Kamiloloa Gulch, in Bermuda grass on the bank of the stream, December 1925, 15 specimens by O. H. Swezey and E. H. Bryan, Jr.[2]

Hawaii, Nauhi Gulch, 5,000-6,000 feet elevation, October, 1931, 14 specimens by O. H. Swezey and F. X. Williams.[3]

All these specimens have been referred to *Lonchoptera furcata* (Fallen), with a query,[4] on the basis of keys and descriptions given by Lundbeck.[5] In sorting out other collections of Diptera in B. P. Bishop Museum, specimens from the following localities have been identified as this same species, although there is great variation in color:

Kauai, Kaholuamanu, 3,600 feet, Aug. 9, 1928, A. M. Adamson and E. H. Bryan, Jr. (one each).

Kauai, Alakai Swamp, Aug. 10, 1928, one by A. M. Adamson.

Maui, Haleakala Crater, 7,000 feet, March 22, 1932, series by Owen Bryant.

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[1] Proc. Hawaiian Ent. Soc. V: 347, 1924.
[2] Proc. Hawaiian Ent. Soc. VI: 415, 1927.
[3] Proc. Hawaiian Ent. Soc. VIII: 188, 1932.
[4] Proc. Hawaiian Ent. Soc. VIII: 410, 449, 1934.
[5] Wm. Lundbeck, Diptera Danica, pt. 5, pp. 1-18, 1916.

Maui, Kula Pipe Line trail, 4,500-5,000 feet, March 15 and 19, series by Owen Bryant.

During the recent Hawaiian Academy of Science's Mauna Kea expedition, Robert L. Usinger collected seven specimens of Lonchoptera on moist surfaces along the edge of Lake Waiau, 13,007 feet elevation, Mauna Kea, Hawaii, August 11, 1935. Running these down in Curran's key,[6] the specimens readily went to *L. dubia* Curran, as did also the previously collected specimens. But running them down in keys given by Lundbeck[5] and by de Meijere[7] they went as readily to *L. furcata.*

It then became the problem to determine how Curran's *dubia* and Fallen's *furcata* might be distinguished. In his original description of *L. dubia,* Curran[8] states that *"L. dubia* cannot be *furcata* because that species is described as having the bristles of the back of the head wholly yellow, whereas in *dubia* some of the occipital cilia are black and it is only rarely that the dark bristles are reduced to one or two in number. In addition, the fact that males are entirely unknown in *dubia* is strong grounds for believing that our species cannot possibly be the same as the European."

But Lundbeck (5, p. 14) in a detailed description of *L. furcata* says, "postocular bristles yellow, often some of the upper black"; and de Meijere (7, p. 73) states, "Die Scheitelborsten sind alle gelb, von den Cilien am Augenrande sind fast immer einige der oberen in gewisser Richtung schwarz."

I have tabulated the characters given for *L. furcata* and *L. dubia* and compared the results with the specimens found in Hawaii. I can find nothing which will serve to distinguish the two species and include all the variations found among our specimens. All authorities agree that they are dealing with an exceedingly variable species. Color is apparently of no diagnostic value, as specimens collected at the same time and place vary from almost black to light brown with various dark markings. The mesonotum may be brown with one or three longitudinal stripes of various lengths and widths, or it may be entirely dark and more or less gray pollinose.

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[6] C. H. Curran, The families and genera of North American Diptera, pp. 232-233, 1934.

[7] J. C. H. de Meijere, Die Lonchopterem des palaearkischen Gebietes. Tijdschrift voor Entomologie, vol. 49, pp. 44-98, 1906.

[8] C. H. Curran, The North American Lonchopteridae (Diptera), American Museum Novitates No. 696, March 3, 1934.

Regarding Curran's argument that the absence of males is significant, no males have been found in Hawaii, although the females seem to be locally abundant. Also, males of *L. furcata* were unknown to Lundbeck in 1916, and de Meijere (7, p. 75) notes that males are "ausserordentlich selten." He believed (p. 49) that this species propagates mainly by parthenogenesis, and he supports this opinion by noting that the spermatheca is short and devoid of spermatozoa. Only about six males of *L. furcata* were known in 1916.

It is the writer's belief that *Lonchoptera furcata* (Fallen) is an exceedingly variable species of wide distribution, and that it includes specimens from Europe, various parts of the United States and Canada, South America, and Hawaii. This species already has a long list of synonyms in Europe, because of its great variation, and unless there are some more distincive characters for Curran's *L. dubia* than have been pointed out, that name also must be added to the list.

In the Hawaiian Islands this species has now been collected on Kauai, Molokai, Maui, and Hawaii; even making itself apparently at home near the summit of the highest peak between California and New Guinea. It is such a distinctive species that had it been present in any numbers it could scarcely have been overlooked by Dr. R. C. L. Perkins in Hawaii, 1892-1912. It is therefore thought to have immigrated after the beginning of the 20th century, and to have spread throughout the main islands of the group with considerable rapidity, in order to have become so widely distributed in our high native forests.

Insects of Samoa—Concluded

REVIEW BY E. H. BRYAN, JR.

(Presented at the meeting of September 5, 1935)

A masterly "Summary" by Dr. P. A. Buxton brings to a close the valuable series of publications on "Insects of Samoa and other Samoan terrestrial Arthropoda," which has been printed by the British Museum (Natural History), London, April, 1927, to

June, 1935. The 34 fascicles containing 68 contributions by 58 specialists are arranged systematically by insect groups in nine parts. Part I, Orthoptera and Dermaptera, 2 fascicles; part II, Hemiptera, 5 fascicles; part III, Lepidoptera, 4 fascicles; part IV, Coleoptera, 5 fascicles; part V, Hymenoptera, 1 fascicle; part VI, Diptera, 9 fascicles; part VII, other orders of insects, 4 fascicles; part VIII, Terrestrial Arthropoda other than insects, 2 fascicles; and Part IX, Summary and index, 2 fascicles. Only the index remains to be issued.†

In 1930 the writer presented a review* of the parts which had been issued at that time, together with a numerical summary of the species which had been enumerated. The following is given to complete the list of fascicles to date.

Part II. Hemiptera.

Fasc. 4. pp. 163-192, 15 text figures, Jan. 27, 1934.
Herbert Osborn, Cicadellidae (Jassidae).

Fasc. 5. pp. 193-228, 9 text figures, Feb. 23, 1935.
Harry H. Knight, Miridae and Anthocoridae.

Part III. Lepidoptera.

Fasc. 4. pp. 169-290, 13 plates, 12 text figures, Feb. 23, 1935.
W. H. T. Tams, Heterocera.

Part IV. Coleoptera.

Fasc. 5. pp. 249-346, 31 text figures, April 25, 1931.
Sir Guy Marshall, Curculionidae.

Part VI. Diptera.

Fasc. 6. pp. 239-251, 3 text figures, Nov. 22, 1930.
J. R. Malloch, Lonchaeidae, Chloropidae and Piophilidae.

Fasc. 7, pp. 253-256, 1 text figure, Nov. 28, 1931.
J. R. Malloch, Trypetidae.

Fasc. 8, pp. 267-328, 16 text figures, June 23, 1934.

† Part IX, Fasc. 3, pp. 105-159. Addenda et Corrigenda and Index. Issued Dec. 20, 1935.

* Proceedings, Hawaiian Entomological Society, VII, No. 3, pp. 445-451, 1931.

J. R. Malloch, Drosophilidae, Ephydridae, Sphaeroceridae and Milichiidae.

Fasc. 9, pp. 329-366, 15 text figures, Feb. 23, 1935.
J. R. Malloch, Phoridae, Agromyzidae, Micropezidae, Tachinidae and Sarcophagidae.

Part VII. Other orders of insects.

Fasc. 4, pp. 117-129, 8 text figures, Feb. 27, 1932.
H. H. Karny, Psocoptera.

Part IX. Summary and index.

Fasc. 1, pp. 1-31, 6 plates, 2 text figures, Nov. 22, 1930.
P. A. Buxton, Description of the environment.

Fasc. 2, pp. 33-104, June 8, 1935.
P. A. Buxton, Summary.

DR. BUXTON'S SUMMARY

Dr. Buxton points out that 1,603 described species of insects are now known in Samoa, of which 669 species, and also 80 genera, were described as new in the series of publications. Of terrestrial Arthropoda other than insects, 113 species have been dealt with, 52 being apparently endemic, and 15 described as new. Of the insects, 49% of those in Samoa are considered endemic, as compared with 81% of the 4,620 species in Hawaii, and 65% of 2,090 species in the Seychelles.

Dr. Buxton shows that the Samoan insect fauna is "oceanic" in nature, with its relationship essentially Indo-Malayan. He notes that at no point between is there any sudden impoverishment of the fauna, rather a gradual change, the fauna becoming poorer with the passage of each area of sea from west to east. Some slight relationship with Australia is indicated, but very little with America. Affinities with Tonga and Fiji are pointed out.

The characteristics of the Samoan insect fauna are discussed in some detail: the effect of seasons, altitude, and wind; migrant insects, insects of special environments, parasitic species, and introductions by man. A tabulation is given of the number of species, endemic and total, in each order; notes are given on endemic

complexes, certain anomalous genera, and distribution throughout the Samoan group. As in Hawaii, whole orders, such as Protura, Plecoptera, and Mecoptera are entirely absent, while other orders and families are disproportionately represented. Numerous comparisons are made with the insect faunas of Hawaii and the Marquesas, the only other areas in Oceania which have been extensively studied to date.

Book Review

BY E. H. BRYAN, JR.

(Presented at the meeting of November 7, 1935)

Charles H. T. Townsend, Manual of Myiology, Part II, Sao Paulo, Brazil, 289 pp., 9 pls., 1935.

This second part of a series of twelve on Muscoid Diptera discusses their classification and habits. It begins with an essay on nomenclature, showing how the whole classification of muscoid flies was changed by the decision of the International Commission on Zoological Nomenclature that *Musca domestica* was the type of the genus Musca, and hence of the family Muscidae, rather than *vomitoria* Linné. Proof is offered that the latter should be the type, and the consequent different classification noted. The principle of priority and the designation of genotypes is discussed.

A list of abbrevations is given for the names of authors who have described flies. In discussing the history and principles of taxonomy, emphasis is laid on generic concepts and the typic-atypic system, which is further elaborated in the section on classification. A section on terminology contains a long alphabetical list of approved terms.

The balance of the book is devoted to a detailed discussion of the classification of muscoid Diptera, with keys to superfamilies, families, tribes and genera. For each tribe there is a discussion of habits as well as morphological diagnoses and keys to genera. A list of muscoid synonymy and a full index to genera make this part of the book readily usable.

PRESIDENTIAL ADDRESS

Insects and Plant Diseases[1]

BY WALTER CARTER

(Presented at the meeting of December 5, 1935)

There is virtue in a short title but that must not connote that an attempt will be made to review the whole field but rather to discuss some of our local problems in such a manner as to exemplify the field of study of insects and diseases of plants, at the same time stressing what appear now to be the more fundamental aspects.

The simplest relationship between an insect and a pathological condition of the plant is illustrated by the effect of a large colony of mealybugs at the base of a pineapple fruit (3). This results in cracking between the fruit eyes followed by the ingress of Nitidulid beetles and Drosophila and subsequent souring of the fruit. In the absence of control measures two factors tend to bring about colonies of mealybugs large enough to produce this condition, first, mealybugs living on the peduncle and green fruit tend to produce more young than those feeding on leaves and second, the fruit develops during a season of rising temperature and drier weather, both favorable to the development of large colonies. This condition of the fruit involves no transmission by the insect primarily involved but the immediate environment is so modified that an insect succession is initiated which results in invasion of fungi and yeasts.

A much more complicated case of an insect in relation to a plant disease is found in leafhopper burn. This in Hawaii is due to *Empoasca solana* DeLong. Although this disease has been merely recorded (12) and not by any means carefully studied it is clearly a case similar to the typical leafhopper burn of potatoes of the mainland and is interpretable as due to a toxic secretion of the insect which produces only local symptoms though not local enough to be limited to the insect's feeding parts. Herford (10)

[1] Published with the approval of the Director as Miscellaneous Paper No. 19 of the Pineapple Producers' Co-operative Association, University of Hawaii.

has shown that this insect secretes diastase and invertase, the former being associated with yeasts in the intestinal tract.

Studies on the nature of insect secretions are very much to be desired. Why, for example, does *E. solana* produce similar effects on watermelon and castor beans and to a very much milder degree on potatoes while on *Amaranthus* it produces only a stippling of chlorotic spots. Are these differences and similarities due only to plant reactions to an insect's specific secretion or are these secretions as variable as the plant saps from which they are synthesized?

Clear-cut evidence on the relationship between change of host and changed insect secretion is to be found in a consideration of another type of local secretion effect, namely, mealybug green spot (5). That this insect's secretion is toxic is clear from the pathological changes induced in the plant tissue at the point of feeding and the effect of severe cases on the functioning leaf tissue.

In this case it is easily demonstrable that a change of host from pineapple to panicum grass so disturbs the insect's physiology as to completely eliminate the capacity of the insect to produce green spots. A further point of considerable importance lies in the fact that this change is not complete until the emergence of the 2nd generation of mealybugs on the panicum grass.

In the field, both green spotting and non-green spotting colonies are present and although intensity of green spotting by any one colony fluctuates, colonies of non-green spotting mealybugs have been maintained for five years without any green spots appearing, and we are justified in considering this last type as a separate strain.

The evidence is clear-cut in this interesting and unique case that a change of host plant brings about profound changes in the insect's physiology and in addition to this we have concrete evidence on the probable locus of this functional change. *Pseudococcus brevipes,* in common with other insects of the order, possesses an elaborate internal micro-flora which is localized as in other species of the genus *Pseudococcus* in an unpaired organ situated in close apposition with the mid-gut of the insect and known as a mycetome (7).

The two strains, one green spotting and the other non-green spotting, show definite differences in their respective micro-flora and the status of the green spotting strain in this respect is changed to that of the non-green spotting strain when the former is transferred from pineapple to panicum grass (9).

The close correlation between the phenomena of green spotting and symbiosis strongly suggests that symbionts are intimately connected with the insect's nutrition and at the same time they themselves are remarkably susceptible to radical changes in the insect's food.

This whole picture is a most intriguing one, for the vast majority of insects transmitting diseases (apart from those involving the simple transfer of pathogens) are polyphytophagous sucking insects with highly developed internal symbiosis.

The separation of these insect species into separate physiological strains of more or less stability and with varying capacities as related to transmission of plant diseases, may well be brought about by appropriate host plant sequences of the insect.

Returning to a consideration of specific toxic effects brings us to mealybug wilt. This disease, the systemic effect of a toxic secretion of the insect (4), is a type of which very few examples are known and fewer still have been carefully studied. In the writer's approach to the problem, the study of mealybug populations in the field came first and as far as possible this was done on a quantitative basis (1). Such a procedure is highly desirable with any problem in economic entomology and in the case of mealybug wilt proved of particular significance.

"Wilt" was in fact known as "edge wilt" long before its relationship to mealybugs was suspected. These population studies showed clearly that mealybug populations advanced into the field from the edge, being moved from wild vegetation by ants. They showed that movement into the field was much more rapid in beds planted at right angles to the margin than in beds running parallel to the margin and it was these data supplemented by observations on chance plantings throughout the pineapple growing areas that led to the development of a simple but highly effective adjunct to control measures—the guard row planting along field borders (2).

Studies of mealybug populations on planting material both before and after planting helped to explain why infestations were frequently limited to field edges, for it has been repeatedly shown that mealybugs disappear unless ants are in attendance. Exceptions to this occur to a degree which is of economic importance but the generalization is fully supported by the quantitative data.

Finally, the methods of quantitative determination of mealybug colonies have been of primary importance in the development of suitable spray techniques.

Although control of mealybug wilt has become a routine matter of mealybug control as far as plantations are concerned, the relationship between the insect and the disease has already provided, and will continue to provide, an absorbing subject for study.

After preliminary evidence as to this relationship was obtained by J. F. Illingworth (11), the writer was concerned with establishing of conclusive proof. This was accomplished first under laboratory conditions wherein all insects but mealybugs were rigidly excluded, and later under field conditions. As these studies progressed it became increasingly evident that mealybug wilt was in a category for which criteria were essentially lacking, namely the insect secreted toxin disease. Since the tendency under the circumstances was to draw analogies with viruses, the writer has devoted considerable study to this phase of the subject and has listed in Table 1 the principal points of difference between mealybug wilt and viruses as generally understood.

TABLE 1.

Comparison of Virus Characteristics with Those of a Toxin as Exemplified by Mealybug Wilt

TOXIN	VIRUS
No evidence for multiplication; new tissue arising after bugs are removed is symptom-free.	Multiplication of virus within the host plant typical and without exception.
Recovery usual: depends on dosage and length of time dose operates.	Recovery extremely rare.
No symptoms ever observed on any other host.	Wide range of host plants usual.
Length of colony's feeding time correlated with amount of wilt produced.	Feeding time necessary for virus transmittal is a matter of minutes.
Wilt is determined by number of bugs and length of time they feed, i.e., a mass-action phenomenon.	Mass-action not a factor.
Sub-wilting populations commonly encountered invariably produce wilt if left to develop.	Non-infectious colony produces no virus symptoms however long it operates or however large it becomes.
Capacity to produce wilt is inherent in the insect.	Insect acquires virus by feeding on diseased plant.
Vegetative reproductions normal except where mother plant reserves have suffered on account of long continued mealybug feeding.	Vegetative reproductions all carry virus.
Control is effected by control of established insect colonies.	No control effected by removal of insect vector.

These points of difference are not, of course, all of equal rank and further study may bring the two concepts closer together in some one or other respect. The table as given, however, is adequate to separate the categories of virus and toxin and to show that there is nothing in mealybug wilt to indicate that a virus is involved.

From the fundamental standpoint the effect of the insect's host sequence is probably of considerable significance. The toxicity of *brevipes* secretions is clearly governed by the host plant from which the insect comes. Furthermore, in the case of a plant which exhibits as many physiological states as does the pineapple it has been demonstrated that colonies of mealybugs taken from various growth states will show striking differences in toxicity. The obvious conclusion is that the toxiniferous state of a toxicological insect is a direct consequence of the state of the insect's nutrition.

Studies of mass action followed as a logical consequence of the hypothesis that mealybug wilt was due to a toxin. The statistical approach to this aspect of the problem has been of little value (8). Briefly stated, the problem has been to learn what is the "toxic dose" necessary to produce wilt. If one mealybug's feeding for one day is taken as the toxic unit it is apparent that in general the greater the number of toxic units the more wilt results. As is to be expected, data from these experiments rarely graph out as a simple straight line, and although some of the deviations are extremely obscure as to their cause they do suggest that toxin, plant and physical environment are in a rather delicate and easily disturbed adjustment.

Table 2 gives the results from one field experiment on the relationship between number of mealybugs, the length of time they operated, and resulting wilt. No two experiments of this type ever give exactly the same results for the reason that the actual number of mealybugs used and the length of time they are allowed to feed are the only two factors under control.

TABLE 2.

EFFECT OF VARYING NUMBERS OF MEALYBUGS ALLOWED TO FEED FOR VARYING PERIODS OF TIME

	No. of mealybugs				
	1	5	10	25	50
No. of days	No. of plants wilting				
20	1	0	1	9	8
15	0	0	1	2	2
11	0	1	2	2	6
5	0	1	3	0	3
2	0	0	0	3	2
1	0	0	0	1	0

Each plot contained 20 plants

A toxic effect naturally suggests possible anti-toxic effects. Two lines of investigation indicate that these do exist. One is on the factor of recovery, the other on the accommodation of the

plant to a gradually developing mealybug colony. The first of these is of little if any commercial significance but nevertheless is a constantly recurring phenomenon. As soon as mealybugs are removed from or leave a wilting plant, that plant begins to produce new and apparently normal tissue. The ability of the plant to support a large colony of mealybugs without wilting is of considerable practical importance for in this manner centers of infestation may develop which disperse later, causing quick wilt in the surrounding plants. The only explantation for this phenomenon at the present time is that such colonies develop from one or two individuals and that the plant is able to accommodate itself to the gradually increasing mass of toxin injected into it.

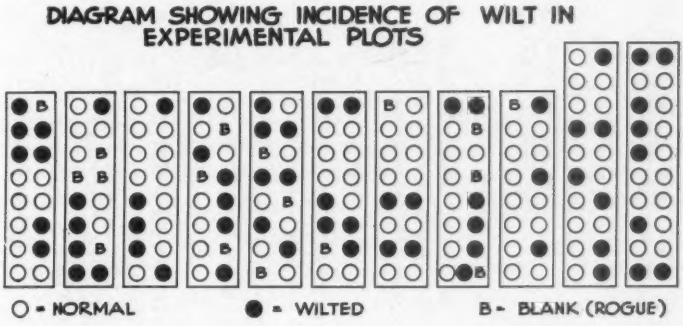

FIGURE 1

The state of our knowledge of mealybug wilt thus far has led to the subject of plant susceptibility and the factors governing it. No definite conclusions are yet available, but one instance can be quoted to indicate what seems to be an interesting lead. It has been the writer's habit to make maps of experimental plots to indicate the position of wilted plants. This has been done because some of the earliest field experiments suggested that the position of plants in a small 20-plant plot affected their susceptibility. Some of the more striking examples of this are shown in Fig. 1. The immediate problem is to determine to what extent this distribution is due to chance and to what extent to the micro-environment. Other subjects of investigation connected with the general problem of

THE STUDY OF MEALY BUG WILT

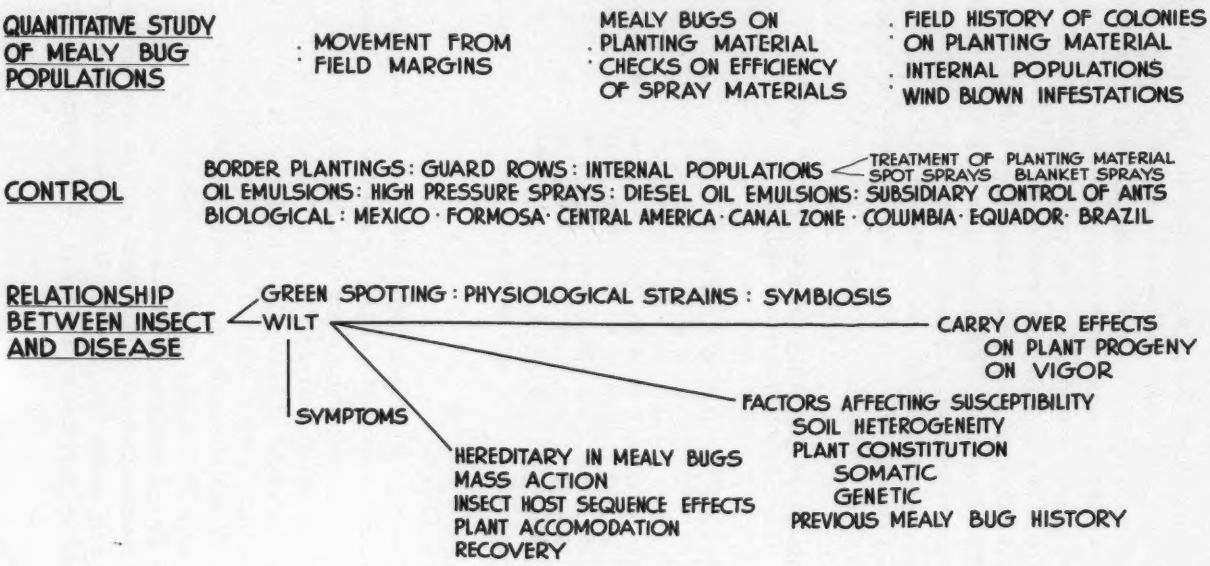
QUANTITATIVE STUDY OF MEALY BUG POPULATIONS
. MOVEMENT FROM FIELD MARGINS
MEALY BUGS ON PLANTING MATERIAL
. CHECKS ON EFFICIENCY OF SPRAY MATERIALS
. FIELD HISTORY OF COLONIES ON PLANTING MATERIAL
. INTERNAL POPULATIONS
. WIND BLOWN INFESTATIONS
CONTROL
BORDER PLANTINGS: GUARD ROWS: INTERNAL POPULATIONS
TREATMENT OF PLANTING MATERIAL
SPOT SPRAYS BLANKET SPRAYS
OIL EMULSIONS: HIGH PRESSURE SPRAYS: DIESEL OIL EMULSIONS: SUBSIDIARY CONTROL OF ANTS
BIOLOGICAL: MEXICO · FORMOSA · CENTRAL AMERICA · CANAL ZONE · COLUMBIA · EQUADOR · BRAZIL
RELATIONSHIP BETWEEN INSECT AND DISEASE
GREEN SPOTTING: PHYSIOLOGICAL STRAINS: SYMBIOSIS
WILT
CARRY OVER EFFECTS
ON PLANT PROGENY
ON VIGOR
FACTORS AFFECTING SUSCEPTIBILITY
SOIL HETEROGENEITY
PLANT CONSTITUTION
SOMATIC
GENETIC
PREVIOUS MEALY BUG HISTORY
SYMPTOMS
HEREDITARY IN MEALY BUGS
MASS ACTION
INSECT HOST SEQUENCE EFFECTS
PLANT ACCOMODATION
RECOVERY

FIGURE 2

plant susceptibility as well as a summary of control methods are shown in Fig. 2.

We now come to a brief discussion of viruses. Pineapple growers are fortunate in that only one virus has been recognized in the field. This virus, commonly called yellow spot, is of very great interest in that it is one of a small group of thrips transmitted virus diseases, its vector is the common cosmopolitan onion thrips and the disease is not known to occur elsewhere than in the islands.

At the time that Linford (13) succeeded in establishing proof of the relationship between the disease and its vector there was considerable fear that the disease would become a limiting factor. Fortunately this fear has not been realized for apart from spasmodic outbreaks of the disease in some sections its status is that of a minor problem.

The reasons for this are at present largely a matter of surmise although attempts are being made to establish, again by quantitative methods, the relationship between field occurring thrips populations, the disease in wild hosts, and in pineapple. The problem is complicated by the fact that the pineapple is not a normal host of *Thrips tabaci* Lind. and the disease only occurs on that plant as a result of a temporary and incidental feeding by the insect. For that reason perhaps, it is possible to find within the confines of a pineapple field, scattered weed hosts of the insect and disease, heavily infested with thrips and infected with virus while the pineapple plants are either free from the disease or showing only an extremely low percentage of infection. The converse does not hold true, that is, no case is known where high percentage of disease in pineapple has not been associated with a similar condition in the weed hosts.

Due to the difficulties of mechanical transmission of this virus many fundamental data are lacking, especially concerning the properties of the virus, which, if available, would enable us to determine the relationships between this virus and others probably allied to it.

What is the original source of the yellow spot virus? This question is put in order to open what is a purely speculative phase of this paper, but one which is of general significance wherever plants are grown and of peculiar interest to Hawaii.

The onion thrips is unquestionably an introduced insect in the islands yet the virus of yellow spot, while allied apparently to spotted wilt of tomatoes and other crops, is not known elsewhere. Two hypotheses are therefore tenable. One is that the insect was viruliferous when introduced here and that the virus is present but not recognized at the point of origin of the thrips. The other is that on being introduced here, the insect acquired the virus from some of the many wild hosts, which, with the natural spread of the insect, was finally communicated to *Emilia sagittata*. This last plant is at present the principal known reservoir of the virus and one of the most favorable hosts for *T. tabaci*.

Either of these hypotheses leads to the same conclusion—that a new economic virus may arise (i.e., be recognized) as a result of the bringing together of potentional insect vectors and new host plant sequences.

Another case in point is that of *Commelina nudiflora* mosaic with respect to pineapple. The writer, postulating that any established virus might possibly be capable of infecting pineapple, succeeded in transmitting this virus to pineapple by mechanical means (6). Later, successful inoculation was accomplished using three species of aphids. The disease in pineapple is severe and frequently lethal. It is not yet known to occur in the field although its symptoms on pineapple are so similar to those of yellow spot that it may easily be passing as the latter disease.

The case is quoted here as illustrating how a virus, well established on weeds, may only await the advent of an efficient vector to become a "new" virus on an economic plant.

The constant stream of descriptions of new viruses may not be due altogether to increased interest on the part of biologists but in part at least to the wider distribution of insect vectors and virus host plants attributable to the development of world agriculture and transportation.

It is at this point that the significance to Hawaii will be apparent to all of us. Situated as we are at an ocean crossroads with an increasing volume of traffic and with new and faster methods of transportation it is inevitable that new floras and faunas will meet here and viruses emerge as a result of new combinations of vectors and plant hosts.

This discussion has thus far tacitly assumed that viruses are living entities which cannot arise purely *de novo* and the theory presented deals only with the *expression* of viruses as a result of new host-insect combinations.[2]

If further study confirms the protein theory of viruses (14) or of some viruses, then true *de novo* genesis of viruses can be considered as possible and the appearance of new viruses or chemical mutants of existing viruses only limited by the factors limiting the arrangement and rearrangement of complex protein molecules.

There is a provocative liason between this last theory and some of the data presented earlier in this paper on insect secretions and the relation of symbiosis thereto. The elaboration of protein virus molecules may well be conditioned by the factors of insect nutrition and secretions, and so-called incubation periods of viruses in insects may perhaps be periods necessary for such elaboration.

LITERATURE CITED

1. Carter, Walter. Studies of populations of *Pseudococcus brevipes* (Ckl.) occurring on pineapple plants. Ecology, 13 (3) :296-304. July 1932.

2. .... Border plantings as guard rows in pineapple mealybug control. Jour. Econ. Ent., 25 (5) :1027-1030. October 1932.

3. Carter, Walter and K. Ito. Some effects of *Pseudococcus brevipes* (Ckl.) on pineapple fruit. Proc. Haw'n Ent. Soc. for the year 1931. 8(1) :37-39. November 1932.

4. Carter, Walter. The pineapple mealybug, *Pseudococcus brevipes* and wilt of pineapples. Phytopath., 23(3) :207-242. March 1933.

5. .... The spotting of pineapple leaves caused by *Pseudococcus brevipes* (Ckl.), the pineapple mealybug. Phytopath., 23(3) : 243-259. March 1933.

6. .... Mechanical transmission of two viruses to pineapple. Abs. in Phytopath., 25(1) :10, January 1935.

7. .... The symbionts of *Pseudococcus brevipes* (Ckl.). Ann. Ent. Soc. of America, 28(1) :60-64. March 1935.

8. Carter, Walter and Carl T. Schmidt. Mass action phenomena in mealybug wilt. Ann. Ent. Soc. of America, 28(3) :396-403. September 1935.

[2] Since this was written a somewhat similar point of view has been expressed by Leach in "Insect and Plant Diseases", Bot. Rev., Vol. 1, No. 11, 1935.

9. Carter, Walter. The symbionts of *Pseudococcus brevipes* (Ckl.) in relation to a phytotoxic secretion of the insect. Phytopathology. (In press).

10. Herford, G. V. B. Studies on the secretion of diastase and invertase by *Empoasca solana* Delong (Rhynchota, Homoptera, Jassidae). Ann. Appl. Biol., 22(2) :May 1935.

11. Illingworth, J. F. Preliminary report on evidence that mealybugs are an important factor in pineapple wilt. Jour. Econ. Ent., 24(4) :877-889. August 1931.

12. Ito, K. and Walter Carter. Notes on insects found on pineapple planting material. Proc. Haw'n Ent. Soc. for the year 1931. 8(1) :41-44 November 1932.

13. Linford, M. B. Transmission of pineapple yellow spot virus by *Thrips tabaci*. Phytopath., 22(4) :301-324. April 1932.

14. Stanley, W. M. Isolation of a crystalline protein possessing the properties of tobacco-mosaic virus. Science, 81(2113) : June 28, 1935.

A New Genus and Species of Encyrtidae Parasitic in the Pineapple Mealybug, Pseudococcus brevipes (Ckll.)[1]

BY HAROLD COMPERE

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Citrus Experiment Station, Riverside, California

(Presented by Dr. Carter at the meeting of November 7, 1935)

At the request of Dr. Walter Carter, Hawaiian Pineapple Growers' Experiment Station, Honolulu, T. H., an effort was made by the writer while in Brazil to ascertain whether any effective parasites of the pineapple mealybug, *Pseudococcus brevipes* (Ckll.), occur there. The species described in this paper was obtained from Edson J. Hambleton, Institute Biologico, São Paulo, Brazil. In a letter accompanying the specimens, Hambleton wrote:

"Under separate cover I am sending you four vials containing an interesting parasite bred from *Pseudococcus brevipes* on pineapples. . . . The pseudococcids were collected at Araras, São Paulo, July 10, 1935. The parasites began emerging on the 24th and continued to do so until today. From the mummified mealybugs you may judge that the species is an effective one. Few, if any, *P. brevipes* escaped attack."

The mummified mealybugs sent by Hambleton contain from one to four larvae, pupae, or adults in each. The parasite is undoubtedly a primary species and may be of value if introduced into Hawaii and established there as a parasite of the pineapple mealybug.

This is the third species of Encyrtidae now known to attack *Pseudococcus brevipes* in Brazil. A few specimens of an undetermined *Anagyrus* were reared by the writer from *Pseudococcus brevipes,* collected on pineapples in the markets of Rio de Janeiro, December, 1934. Samples of an encyrtid genus unknown to the writer were exhibited by Adolph Hempel, who obtained them from *Pseudococcus brevipes* infesting pineapples. These were collected at São Jose Dos Campos, Estado São Paulo, in November or December, 1934, by Lepage, who sent them to Hempel.

[1] Paper No. 336, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

Hambletonia new genus. (Fig. 1.)

This large, robust form is most closely related to *Tropidophryne* Compere. It is distinguished from the latter by having the funicle six-jointed instead of four or five jointed; the scape is without a dorsal fold; the pedicel is circular in cross section instead of triangular; the marginal vein is almost as long as the postmarginal vein instead of absent; the anterior margin of the head, in dorsal view, is slightly convex instead of concave, etc.

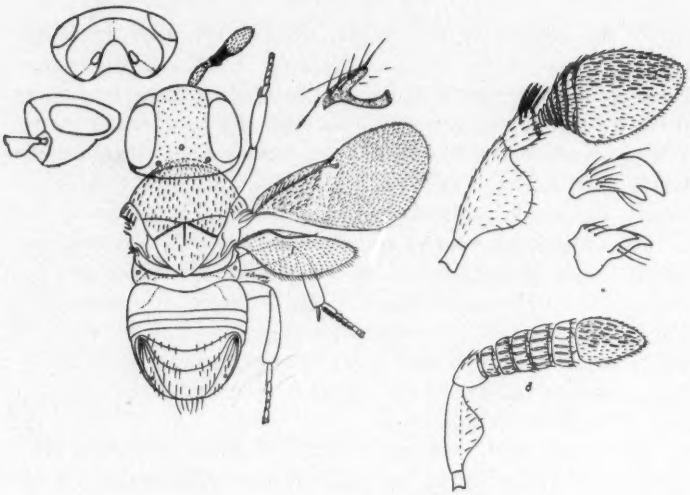

Figure 1. Hambletonia pseudococcina

Female. Head large, horizontal, elongate, and flattened. Face deeply inflexed, semicircular, abruptly meeting the frons in a carinated angle; occiput strongly concave, sharply angled at the vertex. Head, in dorsal view, one and one-half times as long as wide, the anterior and posterior margins slightly convex if the long axis of the head is horizontal. Eyes elongate, oval, mostly dorsal, occupying one-half the width of the head; inner orbits parallel for the most part; a faint suture extends anteriorly from the anterior inner corners of the eyes. Frontovertex longer than wide (7:5) and produced anteriorly in front of the eyes. Ocelli small, in a strongly obtuse triangle. Head, in frontal view, transversely oval, almost twice as wide as high. The scrobes not differentiated from the deep facial depression. The entire antennae can be retracted in the facial depression. Antennal sockets moderately far apart, placed below the middle of the face and separated by a median prominence which projects beyond the facial line. Head, in lateral view, subtriangular, the facial line short, slightly inclined ventro-caudad.

Antennae composed of nine joints. Club solid, massive, cordate. Funicle six-jointed, the first and second joints short and strongly transverse, the following joints greatly increasing in size and laminately expanded. Pedicel large, circular in cross section and with long, coarse, flattened setae on the dorsal margin at apex. Scape widely expanded below and without a dorsal fold. Mandibles bidentate, acute, the outer dorsal tooth much the largest. Maxillary palpi four-jointed; labial palpi three-jointed.

Fore wings partly infuscated, the ciliation basad of the speculum rather sparse and coarse. Marginal vein hardly much longer than wide, slightly shorter than the postmarginal vein; stigmal vein about as long as the marginal and postmarginal veins united.

Form compact, robust; thorax of shallow depth, depressed. When the long axis of the head is horizontal, the posterior part of the head overlaps the pronotum and the anterior portion of the mesoscutum. Pronotum short, transverse. Mesoscutum twice as wide as long. Axillae moderately large, very narrowly separated at inner tips. Scutellum slightly wider than long, as long as the mesoscutum. Abdomen as wide and slightly shorter than the thorax, almost truncate posteriorly. Only six tergites discernible, the fourth and fifth or fifth and sixth tergites may be fused. Ovipositor not protruded. Legs short and comparatively thick.

Male. The male is unlike the female, the head is vertical, convex above; thorax convex, not depressed; antennae eight-jointed, short and thick; general color black, opaque, and shining.

Head normal in size; convex above. Face inflexed but not as much as in the female, meeting the frons in a sharp angle; the scrobes and face not differentiated; the broad raised prominence between the antennae relatively larger than in the female. Head, in dorsal view, slightly concave anteriorly and posteriorly if viewed with the frontovertex in the horizontal plane; frontovertex as wide as long, occupying one-half the width of the head and produced narrowly anterior to the eyes. Head, in lateral view, vertical, subtriangular, the broad high prominence between the antennae jutting out from the face. Ocelli in an obtuse triangle, the posterior pair less than their own diameter from the eye and occipital margins. Antennae composed of eight joints, scape, pedicel, five funicle joints, and solid club. Scape expanded below; pedicel about as wide as long; funicle joints short and wide, increasing in size distad so that the fifth joint is about one and one-half times as large as the first funicle joint; club solid, as wide as the preceding joint and about as long as the three preceding joints.

Fore wings hyaline; the ciliation and venation about as in the female.

Thorax convex; scutellum as long as the mesoscutum; axillae meeting. Abdomen as wide and much shorter than the thorax.

Genotype: *Hambletonia pseudococcina* n. sp.

Hambletonia pseudococcina n. sp. (Figure 1.)

Female. General color brown, translucent. Scape and club blackish. Ventral sides of all coxae and the posterior one-third of the abdomen more

or less fuscous. Frontovertex brown with iridescent reflections. Head apparently destitute of setae; the frontovertex with small widely scattered punctures. Mesoscutum, scutellum, and axillae furnished with short, fine setae; the sculpture of these parts is exceedingly faint and close. Length, 1.8 mm.

Male. General color black, opaque, the mesonotum slightly shining metallic; the sides and venter of the thorax fading to brown. Legs dominantly black to brown, the ends of the femora, tibiae, and tarsi with a variable amount of brown. Antennae light brown or partly fuscous, the scape translucent, brown. Frontovertex finely and closely reticulated and with shallow, faint punctation; the mesoscutum, axillae, and scutellum about as coarsely reticulated but without or with fainter punctation. Dorsum of thorax and head with fine, short setae. Length, 1.2 mm.

Described from 18 females and 7 males, reared from *Pseudococcus brevipes* (Ckll.), Araras, São Paulo, Brazil, by E. J. Hambleton, July, 1935.

Types to be deposited in the United States National Museum.

Several Undescribed Mymarid Egg-Parasites of the Genus Anagrus Haliday

BY HERBERT L. DOZIER

New Orleans, La.

It is interesting to present here the descriptions of two new species of minute egg-parasites of the genus Anagrus. This genus is in such a state of confusion that the identity of a number of species must be cleared up before certain material can be definitely placed. Most of the species can be easily separated by distinctive coloration in life but, unfortunately, this fades when the specimens are mounted in balsam on slides for preservation.

Anagrus insularis new species.

Anagrus insularis is very close in general appearance to **Anagrus subfuscus* Förster, a European egg-parasite of damsel flies, but is distinctly smaller and a shade lighter in coloration. It appears to be undoubtedly an endemic species.

Female. Length, including ovipositor, 0.434 mm.; expanse 1.05 mm.; greatest width of forewing 0.049 mm. General coloration a distinct brown, even the wings being tinged with light brown. Legs and antennae brown, the pedicel and first funicle joint slightly lighter.

Head a little broader than the thorax, the ocelli forming a small triangle. Antennae nine-jointed, comparatively stout, with the club prominent; scape about twice as long as the pedicel and distinctly widened along the middle; pedicel stout, about as wide as the scape but shorter, its length being slightly less than twice its width; funicle 1 very short and narrow; funicle 2 slightly longer than 3 and the other funicle joints, and distinctly the narrowest; the remaining funicles enlarging successively; club about two and a half times as long as the preceding funicle joint. Forewings narrow, longer than the body, broadening towards the apex; widest just before the rounded apex; marginal hairs very long, the longest at the lower apical end being over twice the greatest wing width; the discal cilia sparsely arranged in irregular lines, cover practically the entire area and do not leave a

* *Anagrus subfuscus* Förster appears to be a true aquatic species as it was reared from the eggs of *Calopteryx virgo* L. in leaves of *Nymphaea alba* and *Nuphar luteum* in Europe. It is a dark brown species, measuring 0.6-0.8 mm.

distinct bare or naked space, characteristic of certain species. Hind wings long and narrow, petiolate at base. Abdomen about equal in length to that of both the head and thorax, the ovipositor distinctly but slightly exserted. Legs long and slender, tarsi 4-jointed.

Male. Length 0.392 mm. Similar to the female in color, differentiated immediately by the long, narrow 13-jointed antennae. Funicle 1 subequal the pedicel in length but distinctly narrower; funicle 2 slightly longer than the remaining funicle joints which are subequal in length and width except the last which is shorter and tapered to a point.

Described from a series of sixty-one females and two males mounted in balsam on four slides, reared from eggs in *Ipomoea bona-nox* leaf, Haleauau, Oahu, Hawaii, Sept. 14, 1930; and nine females, mounted on two slides, reared from eggs of Agrion, a native damsel fly, in leaf of *Commelina nudiflora* in Hering Valley, Tantalus, Oahu, August 1933, by F. X. Williams.

Anagrus frequens Perkins.

Numerous females reared by O. H. Swezey from eggs of *Peregrinus maidis* on corn at Honolulu, Hawaii, Oct. 4, 1932.

Anagrus sp.

Both sexes of a species of *Anagrus* reared in abundance from eggs of *Empoasca solana* DeLong in foliage of *Amaranthus spinosus* at Honolulu, Hawaii, June 28, 1930, by O. H. Swezey. This species appears to be closest to *A. giraulti* Crawford but a number of species must be cleared up before naming this species. It has been compared with *Anagrus nigriventris* Girault, *A. empoascae* Dozier, *A. frequens* Perkins, *A. epos* Girault, and *A. columbi* Perkins and proves very distinct from those species.

Anagrus columbi Perkins.

This species was originally described by Perkins in 1905 in Hawaii from material bred from eggs of *Liburnia* sp. on grass at Columbus, Ohio (Koebele No. 2320). It was synonymized by Girault from description only with *armatus* but appears to be a distinct and valid species. Specimens of both sexes collected by the writer sweeping grass in pasture meadow at Hillvale, Pa., August 1, 1933, were rather robust for the genus and of a distinct dull rusty red color in life, thereby differing greatly from typical

armatus. When mounted in balsam on slides, all trace of red fades, leaving the insects with an almost entirely light brown appearance; the scape, pedicel and first funicle are pale, the club and remaining funicle joints distinctly fuscous; the legs light grayish brown.

Erythmelus noeli (Dozier).

This interesting species was described by the writer under the name of *Anagrus noeli* (Jr. Dept. Agr. of Puerto Rico, xvi, no. 2, April 1932, pp. 87-88) from Haiti but upon further study proves to better fit in the genus Erythmelus.

Anagrus delicatus new species.

A very distinct species, easily distinguished from all other North American species by its light brownish color, greatly exserted ovipositor, long antennae, and the arrangement of discal ciliation of the forewings.

Female. Length, including ovipositor, 0.728 mm.; expanse 1.064 mm.; greatest width of forewing 0.053 mm. General coloration a light brown, the body slightly paler along the venter. Antennae dusky, the scape, pedicel, and first funicle joint pale. Legs dusky.

Antennae very long and slender; scape over twice as long as the pedicel, distinctly widened along the middle, with faint transverse lines visible under high power of microscope; pedicel stout, subequal in width to that of the scape but only about half as long; funicle 1 very short, only half as long as the pedicel; funicle 2 very narrow at proximal end, slightly wider at distal end, distinctly the longest joint, being nearly six times as long as greatest width, nearly a fifth longer than funicle 3; funicles 4, 5 and 6 subequal in length and widening successively very gradually; club elongate-oval, three times as long as wide, about twice as long as the last funicle joint. Forewings very long and narrow, widening towards the apex; marginal hairs very long, the longest at the lower apical end being over twice as long as the greatest width of wing; discal ciliation sparse, arranged in a single median line extending from the stigmal vein to near the tip of the wing where the cilia compose three irregular ill-defined rows in the widest area. Abdomen longer than the thorax; ovipositor greatly exserted, extending beyond the tip at least half the length of the abdomen. Legs long and slender, the tarsi 4-jointed.

Male. Length 0.462 mm. Similar to the female but distinguished immediately by the 13-jointed, long and narrow antennae. Antennal joints dusky except the pale pedicel; funicle 1 slightly longer than the pedicel but only about two-thirds as wide; funicle 2 very slightly the longest joint, the others subequal in length and width.

Described from a single holotype female and allotype male swept by the writer from low moist vegetation in bed of creek near Elizabethtown, Illinois, August 5, 1932. This species will probably prove to be an egg-parasite of some aquatic insect when its biology becomes known.

Description of a New Fruit Fly Parasite from Fiji (Hym.)

BY D. T. FULLAWAY

(Presented at the meeting of July 11, 1935)

Opius fijiensis n. sp.

Male and Female. Length of body 4 mm., generally smooth and shining and finely clothed with pale hairs, the head somewhat punctate, particularly on the face and vertex, the mesothoracic scutum bare and highly polished; ochraceous, legs and base of antennae and mandibles concolorous; antennae from the basal segment outwardly, eyes, ocellar space, tips of mandibles and sheaths of ovipositor black. Head transverse, twice as wide as long, wide between the eyes, which are convex; ocelli in the middle of the vertex, the members arranged in an obtuse triangle, with a considerable depression on the outer side of the lateral members; distance from ocelli to eye margin about equal to width of ocellar space (exclusive of the depression beforementioned); antennae considerably longer than the body, 40-segmented, scape and pedicel stout, flagellum filamentous, fairly wide apart at base (space between the antennal socket rings about equal diameter of same, which is twice distance to eye-margin); the front is a flattened space with the ocelli at posterior limit, the antennae just inside the anterior, and without emargination anteriorly or posteriorly but with a thin marginal strip laterally bordering the eyes; face slightly elevated down the middle, almost carinate posteriorly, the clypeus wide (3 times length) and straight margined in front, slightly bowed posteriorly, the clypeal fovea at the lateral angles, the genae rather narrow, post-genae a little wider, mandibles fairly stout, concavo-convex, apparently bidentate apically. Thorax robust, as wide as the head and deeper than wide, sides of the pronotum deeply sulcate, mesothoracic scutum with short and deep foveolate parapsidal furrows near anterior margin, transverse prescutellar sulcus with a pair of large circular median fossae, two smaller ones on either side (in the male only one smaller one on either side); scutellum triangular, slightly convex medially, declivous at the sides; metanotum with a small median triangular process with deep depression on either side; propodeum convex, smooth, declivous behind; stigmata small, circular; mesopleurae with deep and fossulated sulci. Abdomen ovate, somewhat compressed apically, the sides anteriorly collapsed, 1st tergite with a broad, flat central longitudinal ridge, lateral margins of tergite fine and sharply carinate, deep and broad longitudinal grooves between; central part of base of 2nd tergite with short, transverse, shallow groove and a tubercular prominence at its middle; abdomen broadest at apical end of 2nd segment, narrowing gradually from this segment caudally to tip; 2nd-7th

tergites with transverse row of fine golden hairs; ovipositor in female enclosed in sheaths extending beyond tip of abdomen more than its entire length. Legs moderately stout and long. Wings infuscate, stigma and veins black, radius in anterior wings arising a little in front of middle of stigma (which is lanceolate, moderately long and wide) and extending to apex of wing, marginal vein rather thick and heavy nearly to wing tip, second abscissa of radius more than twice length of first transverse cubitus, which is somewhat incrassate above and a little swollen at junction with median vein.

Described from one female (type) and one male (allotype) collected at Naoinee, Fiji Islands, May 28th, 1935, by H. W. Simmonds. Types in Hawaiian Entomological Society type collection.

Thysanoptera of the Hawaiian Islands

BY DUDLEY MOULTON
Redwood City, California

(Presented by O. H. Swezey at the meeting of November 7, 1935)

This paper adds one genus, five new species and five previously known species to the fauna of the Hawaiian Islands, as listed in my earlier papers.* Many other specimens of species listed in the earlier papers were included in the numerous collections forwarded to me for identification but reference is not made to them here. I am deeply indebted to Messrs. O. H. Swezey, F. X. Williams, Walter Carter, K. Sakimura, K. Ito and others for the great interest they have taken in the Thysanoptera. This is evidenced by the scores of collections they have made and the hundreds of specimens they have forwarded to me for study. Type specimens of the new species described and others are being deposited in the collection of the Hawaiian Entomological Society, Honolulu. Other types remain in the author's collection.

TEREBRANTIA

Superfamily THRIPOIDEA Hood, 1915.

Family THRIPIDAE Uzel, 1895.

Subfamily HELIOTHRIPINAE Karny, 1921.

Hercothrips femoralis (Reuter).

Numerous specimens of this species were taken in a greenhouse June 27, 1930, at Manoa, Oahu, on the following plants: *Emilia flammea, Senecio,* egg plant, yellow pualele, in addition to plants previously recorded. (K. Sakimura) (No. 4341).

Subfamily CHIROTHRIPINAE Karny.

Chirothrips sacchari new species.

Female holotype: Head, thorax, tip of abdonmen, antennal segments five

* Thysanoptera of the Hawaiian Islands. Proc. Haw. Ent. Soc. VII, No. 1, pp. 105-134, June, 1928. New Thysanoptera of the Hawaiian Islands. Proc. Haw. Ent. Soc., VIII, No. 3, pp. 499-503, July, 1934.

to eight and wings light brown; legs, abdomen and first four antennal segments, yellow.

Total body length 1.01 mm.; head length 0.126 mm., width 0.116 mm.; prothorax length 0.19 mm., width in front 0.126 mm., behind 0.273 mm.; abdomen width 0.33 mm.; antennal segments length (width) I, 23 (43); II, 26 to base of third segment, 43 to tip of angular process (26 near middle); III, 33 (26); IV, 26 (26); V, 23 (20); VI, 36 (16); VII, 10; VIII, 10; total 193 microns. Spines on ninth abdominal segment 66 and on tenth 100 microns.

Type material: female holotype, and five female paratypes taken on sugar cane February 27, 1929 (O. H. Swezey) (No. 3571).

Type locality: Kailua, Oahu, T.H.

This species may be compared with *mexicanus* Crawford, but is readily separated by the following characters: there are four to six forehead setae as compared with two in *mexicanus,* also there are two longitudinal veins in the fore wing as compared with one in *mexicanus.* The first antennal segment in *mexicanus* is deep brown while in *sacchari* it is yellow or very slightly shaded with grey. The pair of spines on each posterior angle of the prothorax are stronger in *mexicanus* while in this species they are only a little longer than other setae at the angles and along the posterior margin.

Chirothrips fulvus new species.

Female holotype: Head, antennal segments one and three to eight brown, thorax and abdomen brownish yellow, darker at sides; second antennal segment yellow at extreme base, fore tibiae and tarsi likewise yellow, otherwise legs are brownish yellow darkened on the outer sides; fore wings light brown with an irregular whitish cross band in second sixth, this white area continuing along anterior margin in front of fore vein to past middle of wing; hind wings clear.

Total body length 1.08 mm.; head length 0.11 mm., width 0.12 mm.; prothorax length 0.20 mm., width 0.13 mm. in front and 0.27 mm. behind; antennal segments length (width): I, 16 (46); II, 30 to base of third, 46 to tip (26 across middle); III, 33 (23); IV, 33 (26); V, 26 (20); VI, 40 (16); VII, 10; VIII, 13; total 210 microns. Spines on posterior angles of prothorax, outer 16 and inner 26 microns; spines at tip of abdomen 76 microns.

Male allotype: yellow with head and tip of abdomen slightly brownish. Total length of body 0.82 mm. Wings wanting.

Type material: female holotype, male allotype and two male and ten female paratypes taken on *Paspalum orbiculare,* June 16, 1930. (K. Sakimura). (No. 4337).

Type locality: Paumalu, Oahu, T. H.

The species is distinguished by having fifteen to seventeen forehead setae and the ocellar pair placed opposite anterior ocellus, by the enlarged first antennal segments, fore wings with light bands also the fore vein of fore wing has four spines near base and two near tip; the hind vein has five rather regularly placed spines.

This species may be compared with *vestis* Hood but is easily separated from this latter species which has the first antennal segment clear yellow, the pronotum closely and prominently set with short, stout spines along median fourth and similar patches of spines in middle of first four of five abdominal segments. The setae are small and scattered on the pronotum of *fulvus* and are not visible on the abdominal segments.

Subfamily THRIPINAE Karny

Taeniothrips carteri new species.

Female holotype: head and body color chestnut brown; all femora colored like body except tips of fore pair which are yellow; fore tibiae yellow shaded with brown at the margins, middle and hind tibiae brown in the middle, lighter at both ends; antennal segments one, two and four to eight dark brown, three mostly yellow shaded with greyish brown in outer half; wings clear.

Total body length 1.5 mm.; head length .147 mm.; width .17 mm.; prothorax length .147 mm., width .205 mm.; pterothorax width, .28 mm. Antennal segments length (width) III, 56 (21); IV, 46; V, 40; VI, 53; VII, 10; VIII, 13; total 260 microns. Length of spines: interocellar 36, on posterior angles of prothorax, outer 60, inner 73; on ninth and tenth abdominal segments 133 microns.

Head only a little wider than long, cheeks almost straight, ocelli present, interocellar spines placed outside the ocellar triangle almost on a line crossing at the posterior margin of anterior ocellus. Antennal segments seven and eight small, almost subequal. Prothorax with three spines on either side along posterior margin. Median pair of spines on metanotum placed 10 microns back from anterior margin. Comb on eighth abdominal segment entirely wanting. Fore vein of fore wing with 3-3 basal spines and three distal spines in outer half of wing; hind vein with twelve spines.

Type material: female holotype taken on onion, June 13, 1930. (Walter Carter) (Moulton No. 4344). Type in author's collection.

Type locality: Kilauea, Kauai, T. H.

This species may be separated from *hawaiiensis* Morgan, by the clear color of its wings, in the latter species the fore wings being clear at base and brown beyond. In *hawaiiensis* the legs are mostly yellow and the comb along posterior margin of eighth abdominal segment is complete.

The writer takes pleasure in naming this species after Dr. Walter Carter, the collector.

Taeniothrips simplex Morison.

Numerous specimens taken on gladioli November 16, 1932, at Nuuanu, Oahu, T. H. (Q. C. Chock) (No. 5416). This is recognized as the gladiolus thrips and was formerly known as *T. gladioli* M. & S.

Thrips panicus Moulton.

Numerous specimens of this thrips have been taken in the Hawaiian Islands with hosts and records as follows: Sugar cane, Molokai, January 25, 1929 (O. H. Swezey) (No. 3272); rice, Honolulu, April 17, 1928 (O. H. Swezey) (No. 3531); Echinochloa, Kailua, Oahu, April 11, 1929 (O. H. Swezey) (No. 3538); *Cenchrus echinatus,* April 7, 1930 (K. Sakimura) (No. 4343); pineapple, Manoa, Oahu, April 19, 1930 (K. Ito) (No. 4338); *Eleusine indica,* February 18, 1930, Waipio, Oahu (K. Ito) (No. 4339); pineapple, Waipio, Oahu, December 20, 1930 (Walter Carter); on pineapple plants in quarantine house, Honolulu, April 18, 1934 (Walter Carter). Other collections have been sent in for identification but the hosts and localities as they relate to the Hawaiian Islands are covered in the above references.

This species has also been taken on sugar cane in Cuba and the writer collected it on sugar cane in São Paulo, Brazil, in 1929.

Thrips trehernei Priesner.

One specimen taken on pineapple, June 19, 1930, at Manoa, Oahu (K. Ito) (No. 4338).

TUBULIFERA

Superfamily PHLOEOTHRIPOIDEA Hood, 1915

Family PHLOEOTHRIPIDAE Uzel, 1895

Subfamily PHLOEOTHRIPINAE Karny, 1921

Tribe HOPLOTHRIPINI Priesner, 1927

Hoplothrips hawaiiensis new species.

Female holotype: Color dark chestnut brown with median portion of head and first abdominal segments somewhat lighter; all femora, middle and hind tibiae dark brown, yellow at joints, fore tibiae clear yellow or with a slight shading of light brown; fore tarsi yellowish, others light brown. Antennal segments one, two and most of four to eight dark brown, three yellowish in basal half, light brown in distal half, basal third of four and five and extreme base of six yellow.

Total body length 2.7 mm. Head length .294 mm., width .245 mm.; prothorax length .20 mm., width without coxae .375 mm.; width of mesothorax .42 mm.; tube length .22 mm., width at base .088 mm. Antennal segments length (width): I, 53(50); II, 66(40); III, 93(43); IV, 90(43); V, 83(40); VI, 73(36); VII, 66; VIII, 50; total 588 microns. Length of spines: postoculars 83, on anterior margin and angles of prothorax vestigial, midlaterals 133, on posterior angles, outer 80, inner 50, inner long pair on posterior margin of ninth abdominal segment 133, three small spines on posterior angles 40 to 50, with the middle spine immediately at the angle some longer than the others, at tip of tube about 166 microns.

Head 1.2 longer than wide, angular in front, eyes distinctly flattened on their outer margins, cheeks nearly parallel but constricted at neck; back of head with transverse reticulation; only a very few inconspicuous cheek spines. Antenna twice longer than head, three to six clavate, eight slightly constricted at base. Prothorax about two-thirds as long as head, with prominent midlateral spines which are longer than those on posterior angles and in turn the inner spines of this pair are shortest. Fore femora moderately thickened, each fore tarsus armed with a rather sharp but broad-seated tooth. Wings wanting. Tube .75 as long as head. A pair of very weak wing retaining spines on abdominal segments three to seven and a single long prominent spine near posterior margin on each side, the regular angular spines are all vestigial; this condition holds also for the ninth abdominal segment where there is only one prominent spine on either side, the angular spines are reduced to setae. In some paratypes this angular spine may be longer but never obtains more than half the length of the other prominent spines.

Male allotype similar to the female except for the greatly enlarged fore femora and the somewhat stronger tooth on each fore tarsus. The small group of small spurs on outer margin of fore coxae are also more prominent. The spine at each posterior angle of ninth abdominal segment is of about the same length as in the female but stouter.

Type material: female holotype, male allotype, one male and seven female paratypes taken in dead frond stems of tree fern, *Cibotium,* March 12, 1932, on Mt. Tantalus, Oahu (Moulton No. 5412) (O. H. Swezey) and on tree fern, *Cibotium menziesii,* July 18, 1927, at Haelaau, Maui. (E. J. Bryan, Jr.) (No. 3543).

This species may be compared with *perkinsi* Bagnall, the only other known species from the Hawaiian Islands in which the spines are so reduced at the posterior angles of abdominal segments; *hawaiiensis,* however, may be separated by its larger size and color. *H. perkinsi* is described as being 1.8 mm. in length and the antennae are dark brown with the basal part of only the third segment yellowish. *H. swezeyi* is similar in color to *hawaiiensis* but is readily separated by the fully developed spines on abdominal segments.

Hoplothrips coprosmae new species.

Female holotype: very dark chestnut brown with median portion of head and base and tip of tube somewhat lighter; legs mostly dark brown, joints lighter, fore tibiae and all tarsi brownish yellow; antennae mostly dark brown, second segment which is lighter in outer portion, three yellow in basal third, outer portion yellowish brown, four and five yellowish in basal third, six yellowish at extreme base.

Total body length 3.2 mm. with abdomen somewhat distended; head length .367 mm., width .264 mm.; prothorax length .278 mm., width excluding coxae .47 mm.; pterothorax width .54 mm.; tube length .28 mm., width at base .117 mm. Antennal segments length (width) I, 60(60); II, 80(43); III, 110(46); IV, 110(46); V, 100(40); VI, 90(36); VII, 73; VIII, 60; total 690 microns. Length of spines: postoculars 126, on anterior margin vestigial, at anterior angles 30, midlaterals 183, on posterior angles outer 116-130, inner 133, on posterior angles of ninth abdominal segment outer 110, inner 200-216, at tip of tube 216 microns.

Head 1.4 longer than wide, angular in front, eyes flattened on the margins, cheeks slightly rounded and constricted at the neck; with several prominent cheek spines some of which arise from small tubercles; postoculars long and prominent; ocelli fully developed. Antenna 1.85 longer than head, segments three to six clavate. Prothorax .7 as long as head, with a small spine on each anterior angle, midlateral spines longest, pair at each posterior angle also prominent. Fore femora about twice broader than others, fore tarsus armed with a prominent broad-seated tooth. Abdomen broader than pterothorax, with spines at posterior angles of segments well developed, the outer pair on ninth segment about two-thirds as long as inner ones; spines at tip about two-thirds as long as tube. Wings completely wanting.

Male allotype: colored as in female but with fore tibiae distinctly yellow in median portion and darkened with brown on upper and lower margins; fore femora greatly enlarged, fore tarsal tooth strong.

Type material: female holotype, male allotype, five male and three female paratypes together with a number of larvae taken in crack of tree stem, *Coprosma* (O. H. Swezey) (No. 5406) September 29, 1931, and under a stone (F. X. Williams) (No. 5407), at an elevation of 5,500 to 6,000 feet.

Type locality: Nauhi, Hawaii, T. H.

This species can be compared with *ovatus* Bagnall but is much larger and the eighth antennal segment is not abruptly constricted at the base as in *ovatus*.

Polyporothrips biformis (Moulton).

Correction: This species was formerly described under the name *Poecilothrips biformis* (Proceedings of the Hawaiian Entomological Society, Vol. VIII, No. 3, p. 501, July, 1934). A study of additional material, especially of the wingless forms, convinces me that this species should rather be assigned to the genus Polyporothrips.

Tribe HAPLOTHRIPINI Priesner

Aleurodothrips fasciapennis (Franklin).

Specimens taken in San Francisco quarantine in August, 1929, on coconut from Honolulu. (No. 3684).

Haplothrips (Karnyothrips) flavipes Jones.

This species of rather wide distribution is now recorded as found in the Hawaiian Islands. Mr. Swezey has made collections as follows: from *Acacia koa* at Poamoha and Sugar Loaf Hill, November 11, 1933 (M. Nos. 5379, 5380); from dead twigs of *Euphorbia* on Mt. Tantalus, May 20, 1934 (No. 5385) and in blossoms of Lantana at Honolulu, August 20, 1934 (No. 5387).

Subfamily MEGATHRIPINAE Karny, 1921

Tribe MEGATHRIPINI Priesner, 1927

Diceratothrips brevicornis Bag.

One specimen of this species was taken from under bark of *Osteomeles* September 24, 1929, in Manoa Valley, Oahu. (O. H. Swezey) (Moulton No. 3921).

The following brief analysis in addition to Mr. Bagnal's earlier description may be helpful to distinguish this species.

Total body length 3.36 mm. Head length 0.47 mm., width behind eyes 0.26 mm.; prothorax length 0.26 mm., width 0.47 mm.; tube length 0.50 mm., width at base 0.132 mm. Antennal segments length (width) I, 50(53); II, 80(40); III, 133(46); IV, 146(50); V, 126(40); VI, 83(33); VII, 66(30); VIII, 43; total 735 microns. Length of spines: anteocellar 40, postocellar 44, postoculars 166; on anterior margin and angles of prothorax 60, midlaterals 83, on posterior angles inner, 150, outer, broken off; on ninth abdominal segment 500, at tip of tube 150 microns. Basal wing spines 66, 100 and 216 microns respectively.

OBITUARY

Gerrit Parmele Wilder

(Read by O. H. Swezey at the meeting of Dec. 5, 1935)

In the death of Dr. Gerrit Parmele Wilder on September 29th, 1935, the Hawaiian Entomological Society has lost one of its oldest members. Having been born in Honolulu, November 5th, 1863, a long and active career devoted to many interests in the Territory of Hawaii has now come to a close.

Dr. Wilder was elected to membership in the Hawaiian Entomological Society March 9, 1905, only a few months after the organization of the Society. Although not a professional entomologist, he always had a keen interest in the welfare of the Society, his interest in entomology being that of the horticulturist, and entomology has a very vital connection with horticulture.

Dr. Wilder made no contributions to the "Proceedings" of our Society other than brief notes and observations on insects of particular interest or importance with which he came in contact in the garden or forest, or in foreign parts. As he had done much botanical exploring in the later years in the island groups of the South Pacific in connection with discovery and introduction of valuable fruit trees and ornamental trees and plants, he had opportunities for collecting many interesting insects of those regions, and the Bishop Museum collections are enriched with many specimens contributed by Dr. Wilder. A month was spent in Samoa in 1923 in company with Mr. O. H. Swezey, collecting insects and tree seeds, etc. Perhaps this was the beginning of special interest in insects of the South Seas. His name is perpetuated in the following names of insects from that region:

Hyalobathra wilderi Tams, a yellow pyraustine moth.

Xyleborus wilderi Beeson, a scolytid beetle.

Deretiosus wilderi Marshall, a cryptorrhynchine weevil.

Paurocephala wilderi Crawford, a psyllid occurring on Ficus sp.

Swezwilderia bryani Chopard, a cricket.

His whole life was devoted to helping others, giving his time and talents whenever opportunity presented. He will be greatly missed at the meetings of the Society.

Committee

O. H. Swezey.
Edward M. Ehrhorn.

The Insect Fauna of Ieie (Freycinetia arborea) in Hawaii

BY O. H. SWEZEY

(Presented at the meeting of July 11, 1935)

The ieie vine is common in the forests of all the main islands of the Hawaiian group. In places it forms impenetrable tangles both in the absence of trees and also when climbing amongst trees, as is well known by those entomologists who have taken part in insect collecting in the Hawaiian forests. This native plant seems not to be troubled much with insects, but there are a few which are especially attached to it, and others are associated with it in one way or another.

A large number of insects are associated with *Freycinetia arborea* on account of the way the leaves hold water at their bases, and certain scavenger insects find an appropriate habitat amongst a continuously wet mass of accumulated debris. Some insects have their habitat here in order to prey upon other insects. Then, too, some of the insects collected on ieie may have been in temporary hiding, rather than any other particular purpose.

On page 203 of Proc. Haw. Ent. Soc., VI, 1925, I listed 5 species of insects which are attached to *Freycinetia arborea*. A few more could now be added to that list. This paper is an annotated list of what is at present known of the insect fauna of this plant in Hawaii.

LEPIDOPTERA

Catamempsis decipiens Walsm.

The caterpillars of this gelechiid moth feed in the tips of branches, eating the leaves of the unexpanded spindle. There may be a dozen or more feeding somewhat gregariously, and they produce a filthy condition in which such scavenger insects as nitidulid beetles may be found. They do not eat the terminal bud, however, so the growth of the branch continues, but is unsightly from the ragged appearance of the leaves when they have expanded after the caterpillars have finished their eating. The fullgrown caterpillar is about 25 mm., and the moth has a spread of about 40 mm.

It is pale brown with a few black markings on forewing. It is seldom seen, but the caterpillars are often found, and the evidence of their work is commonly seen when one has become acquainted with the appearance of the injured leaves. It is known on Oahu, Molokai, and Hawaii. It probably occurs on the other islands as well.

Euperissus cristatus Butl.

The larvae of this diplosarid moth feed in the pith of dead ieie stems. The fullgrown larva is whitish, elongate, reaching a length of 50 mm. The larva apparently takes a considerable length of time to reach full growth, and eats for several inches, even to a foot or more in the dead stem. Many of them are killed by a fungus disease. Pupation takes place within the stem after a hole has been gnawed in an appropriate place for the exit of the moth when matured. The moth has an expanse of 35 mm. The forewings are pale gray with three black dots in the disk. This moth is known on Oahu, Molokai and Hawaii, and probably occurs on the other islands as well, or wherever the plant occurs.

HOMOPTERA

Pseudococcus montana Ehrhorn.

This mealybug was described from *Freycinetia arborea* in Palolo Valley, Oahu. It has also been recorded from the same plant in the Panaewa forest south of Hilo, Hawaii. Doubtless it occurs wherever the plant occurs. It has also been recorded on *Astelia veratroides* on Mt. Olympus, Oahu. A parasite, *Anagyrus nigricornis* Timb., has been reared from this mealybug. It is not specfic, however, as it has been reared from a few other mealybugs also.

Nesodryas freycinetiae Kirk.

This delphacid was discovered and described from material of all stages collected on ieie on Pacific Heights ridge and Mt. Tantalus, Oahu. It has also been collected on Kahauiki ridge, Oahu, but as yet in no other region.

Ilburnia halia (Kirk.).

This delphacid was described from material collected on ieie on Mt. Tantalus and Pacific Heights ridge, Oahu. It has also been

collected from the same plant on Mt. Olympus and at Kaluanui, Oahu. On Mt. Olympus an egg parasite, *Polynema ciliata* Perkins, was reared from the eggs of this leafhopper.

Ilburnia anceps (Muir).

This delphacid occurs on ieie on the island of Hawaii, having been collected at Glenwood.

Ilburnia sp.

An undetermined species has been collected on ieie on Molokai.

HETEROPTERA

Metrarga contracta Blackburn.

This myodochid bug is occasionally found hiding among the leaf bases. It is probably predacious.

Sulamita lunalilo Kirk.

This mirid bug has been taken abundantly on ieie in Kona, Hawaii. Another mirid has been collected on ieie on Mt. Olympus, Oahu.

Reduviolus procellaris Kirk.

This predacious bug has been collected on ieie on Molokai.

ODONATA

Megalagrion amaurodytum waianaeanum (Perkins).

Megalagrion asteliae (Perkins).

Megalagrion koelense (Blackburn).

Dr. F. X. Williams has found the nymphs of these damselflies living amongst the leaf bases of ieie. The former in the Waianae Mts., Oahu, and the two latter in the Koolau Mts., Oahu. He has made a detailed study of the nymphs and reared them to maturity. They fed upon the various small insects and other small animals which were living in the same situation. No doubt some of the species of Megalagrion occurring on the other islands are also associated with ieie in a similar manner. A mymarid parasite (**Anagrus* sp.) has been reared from one or more species of Megalagrion at various places on Oahu.

* *Anagrus insularis* Dozier (See page 175 of this issue).

Metromenus palmae Blkb.

This carabid is common among leaf bases of ieie on Oahu.

Atelothrus platynoides Sharp.

This carabid was collected on ieie on Molokai.

Several other species of carabids are found similarly where they prey on other insects occurring in the same situation.

One or more species of Staphylinidae have been collected from among the leaf bases of ieie where they are predators.

Nesopetinus discedens (Sharp).

Nesopetinus parallelus (Blkb.).

Eupetinus omalioides (Sharp).

Dr. Perkins recorded these species of Nitidulidae from leaf bases of ieie on Mt. Tantalus, Oahu.

Orthostolus germanus (Sharp).

Eupetinus impressus (Sharp).

These two nitidulids were collected on ieie on Molokai.

No doubt several other species of nitidulids may be found in the same habitat when more thoroughly studied. They are scavengers.

Rhyncogonus koebelei Perkins.

Dr. Williams collected this otiorhynchine beetle on one occasion, hiding among ieie leaf bases on the top of Mt. Olympus, Oahu.

Rhyncogonus segnis Perkins.

On one occasion, collected on ieie at Wahiawa, Oahu, by D. B. Kuhns.

Rhyncogonus freycinetiae Perkins.

This species was collected on different occasions at Helemano, Oahu, on ieie by Dr. Perkins and D. B. Kuhns.

Cis laeticulus Sharp.

Dr. Perkins collected this cioid beetle frequently on dead fallen leaves of ieie. It occurs on Oahu, Molokai, Lanai, Maui and Hawaii.

HYMENOPTERA

Besides the mymarid parasites mentioned above (*Polynema ciliata* and *Anagrus* sp.) Dr. Williams has recorded the nesting of *Odynerus oahuensis* D. T. in a dead stem of ieie.

ISOPTERA

Neotermes connexus Snyder.

This termite has been found in dead stems of ieie on Oahu and Molokai.

ORTHOPTERA

Chelisoches morio (Fab.).

Euboriellia annulipes (Lucas).

These and probably other earwigs are sometimes met with as predators on the insect inhabitants at leaf bases of ieie.

Allacta similis (Sauss.).

This roach is found on ieie as well as on most every kind of plant in the Hawaiian forests.

DIPTERA

Dr. Williams has found larvae of the following Diptera in the wet debris at bases of leaves of ieie, as scavengers:

Forcipomyia ingrami Carter.

Reared from larvae in ieie on Mt. Kaala, 1935. This small fly has also been reared from other situations.

Drosophila sp.

Reared from maggots from fruiting top of ieie on Konahuanui, October, 1935. Several specimens of an undetermined figitid were reared from puparia of this fly.

Psychoda sp.

Reared from the same material as the above.

Undetermined species of Chironomidae, Limnobiidae and Dolichopodidae were reared from similar situations at various places.

COLLEMBOLA

Unidentified species are found in the debris at leaf bases of ieie. Probably there are several species.

Besides all of the insects mentioned, common inhabitants of the habitat among the moist debris at the leaf bases of ieie are several spiders, oribatid mites, sowbugs, the shrimp *Orchestia pickeringii* Dana, small millipeds and centipedes, earthworms and several kinds of snails.

Fruit-eating and Seed-eating Insects in Hawaii

BY O. H. SWEZEY

(Presented at the meeting of May 2, 1935)

In studies of the insect faunas of the various Hawaiian trees and plants, one finds nearly all kinds of fruits and seeds eaten by one or more special kinds of insects. This paper segregates observations on these habits so far as at present known, mostly the observations of the writer during the 30 years in which he has been interested in the Hawaiian insect fauna. Included also are immigrant insects which feed on fruits and seeds, whether of native plants or of introduced plants as well. The list is arranged by systematic orders of insects, the Lepidoptera including by far the largest number of species.

LEPIDOPTERA

Noctuidae

Chloridea obsoleta (Fab.). The caterpillars feed chiefly in the ears of green corn, scarcely an ear of recent years but what is affected by them. Others hosts are cotton bolls, tomato, *Malva* fruits, *Sida* buds and blossoms, *Malvastrum,* the flower heads of several Compositae as African daisy, marigold, *Ageratum, Siegsbeckia, Heterotheca grandiflora,* also the flowers of snapdragon, *Gossypium tomentosum* and *Euxolus.*

Phycitidae

Ephestia cautella Walker. The larvae feed in various grains and grain products.

Plodia interpunctella Hubner. The larvae feed in stored nuts, dried fruits, cereals, etc.

Myelois ceratoniae Zeller. The larvae feed on the seeds in the pods of several legumes as: *Ceratonia siliqua, Acacia farnesiana, Prosopis juliflora, Cassia bicapsularis, Erythrina monosperma, Caesalpinia sappan, Samanea samman, Haematoxylon campechianum,* and sometimes castor oil seeds.

Paralipsa modesta Butler. The larvae sometimes infest stored rice.

Rhynchephestia rhabdotis Hampson. The larvae destroy the seeds in the flower heads of the silversword plant (*Argyroxiphium sandwicense macrocephalum*) growing in the crater of Haleakala on Maui. They also feed at the base of the leaves and in the stem.

Pyraustidae

Terastia meticulalis Guene. The larvae were once found feeding on the seeds in the pods of *Erythrina monosperma.*

Maruca testulalis (Geyer). The larvae feed on the seeds in the pods of Lima beans, string beans, peas, pigeon peas, *Mucuna urens,* and probably other legumes, also in the flowers of *Sesbania grandiflora.*

Orneodidae

Orneodes objurgatella Walsm. The larvae infest very extensively the fruits of *Plectronia odorata.*

Gelechiadae

Platyedra gossypiella (Saund.). This is the pink bollworm, a bad pest on cotton, feeding on the seeds and spoiling the cotton fiber in the unripened bolls. The seeds of *Gossypium tomentosum, Hibiscus youngianus, Hibiscadelphus hualalaiensis* and *Thespesia populnea* are also sometimes affected.

Phthorimaea operculella (Zeller). This is the leafminer in tobacco, potato, *Datura* and tomato. The larvae often feed in the tomato fruits.

Aristotelia elegantior Walsm. Reared from *Gouldia* berries.

Aristotelia compsodelta Meyrick. Reared from *Kadua* capsules.

Sitotroga cerealella (Oliv.). Infests corn and wheat.

Tortricidae

Crocidosema plebeiana Zeller. Has been reared from seeds of *Abutilon menziesii* and *Abutilon eremitopetalum.* The larvae commonly feed in *Sida* buds.

Crocidosema marcidellum (Walsm.). Reared from the seeds of *Hibiscus arnottianus.*

Crocidosema lantana Busck. The larvae feed in lantana berries, also in the flower heads and bore in the tender twigs.

Adenoneura parapteryx Meyrick. The larvae feed in the pods of *Canavalia galeata, C. microcarpa* and *C. turgida.*

Adenoneura plicatum Walsm.

Adenoneura latifemoris Walsm.

Adenoneura montanum Walsm. The larvae of these three species feed on the seeds of *Sophora chrysophylla.*

Adenoneura rufipennis Walsm. The larvae feed on the young seeds in green pods of *Acacia koa.* They also at times feed in the flower buds.

Argyroploce illepida (Butl.). This is the moth whose larvae cause such destruction to the seeds of *Acacia koa.* From numerous counts from various localities, the usual infestation of seeds in koa pods is from 50 to 90 percent. The larvae commonly infest the seeds of *Acacia confusa* and *Acacia farnesiana.* They have also been reared from macadamia nuts, litchi nuts, *Alectryon macrococcus* fruits, seeds of *Dodonaea viscosa* and *Mezoneurum kauaiense,* and rarely from the pulp part of a mango fruit.

Carposinidae

Heterocrossa olivaceonitens Walsm. The larvae live in the fruits of *Sideroxylon sandwicense,* also in the fruits, buds and flowers of several species of *Clermontia.*

Heterocrossa nigronotata Walsm. Reared from the berries of *Suttonia lessertiana.*

Heterocrossa inscripta Walsm. Reared from ohelo berries (*Vaccinium reticulatum*).

Heterocrossa crinifera Walsm. Reared from the capsules of *Kadua grandis.*

Heterocrossa divaricata Walsm. Reared from the fruits of *Elaeocarpus bifidus* and *Syzygium sandwicense.*

Heterocrossa gracillima Walsm. Reared from berries of *Styphelia tameiameia.*

Heterocrossa graminicolor Walsm. Reared from the native olive (*Osmanthus sandwicensis*).

Heterocrossa solutella Walsm. Reared from *Gouldia* berries.

There are 24 more species of *Heterocrossa* in Hawaii and probably the most of them live in various kinds of native fruits.

Lycaenidae

Lycaena boetica (Linn.). The bean butterfly. Its larvae feed on various legumes as string beans, peas, pigeon peas, and several species of *Crotalaria.*

Thecla echion (Linn.). The lantana butterfly whose larvae feed on the flowers of Lantana, but have occasionally been found feeding on the fruits of eggplant, *Solanum nodiflorum, Solanum sanitwongsei* and *Cordia sebestena.*

DIPTERA

Cecidomyidae

Diplosis sorghicola Coq. The maggots feed on the growing seeds of sorghum and Johnson grass.

Ortalidae

Scholastes bimaculatus Hendel. The maggots feed in the meat of injured, sprouted or decaying coconuts.

Trypetidae

Chaetodacus cucurbitae (Coq.). The melonfly whose maggots feed in all kinds of melons, cucumbers, squash, and also in tomato, overripe papaia and string beans.

Ceratitis capitata Wied. The Mediterranean fruitfly whose maggots feed in 72 kinds of fruits including such native fruits as: *Vaccinium, Santalum, Scaevola* and *Wikstroemia.*

Tephritis crassipes (Thom.). The maggots feed on the growing seeds in flower heads of *Bidens pilosa.*

Tephritis cratericola Grim. The maggots feed on the growing seeds in the flower heads of the silversword (*Argyroxiphium sandwicense macrocephalum*).

Tephritis dubautiae Bryan. The maggots feed on the growing seeds in the flower heads of several species of *Dubautia.*

Tephritis sp. An undescribed species feeds in flower heads of endemic species of *Bidens.*

Tephritis sp. An undescribed species feeds in flower heads of several species of *Railliardia.*

Agromyzidae

Ophiomyia lantanae (Froggatt). The maggots feed in Lantana berries.

COLEOPTERA

Bruchidae

Megacerus alternata Bridwell. The larvae feed in the seeds of *Ipomoea pes-caprae, Ipomoea tuberculata* and *Ipomoea fistulosa.*

Bruchus amicus Horn. The larvae feed in the seeds of *Prosopis juliflora.*

Bruchus chinensis Linn. The larvae infest pigeon peas (*Cajanus cajan*).

Bruchus limbatus Horn. Has been reared from seeds of *Samanea saman, Acacia koa, Acacia confusa* and *Albizzia lebbek.*

Bruchus obtectus Say. Infests common beans.

Bruchus phaseoli Gyll. Infests *Dolichos lablab.*

Bruchus pruininus Horn. Chiefly infests seeds of *Leucaena glauca* but also *Acacia confusa* to some extent.

Bruchus sallaei Sharp. Infests seeds of *Prosopis juliflora* and *Acacia farnesiana.*

Bruchus quadrimaculatus Fab. Has been reared from cowpeas, pigeon peas and peanut.

Bruchus prosopis Lec. Infests seeds of *Prosopis juliflora,* and has also been reared from *Acacia confusa.*

Pachymerus gonagra (Fab.). Infests seeds of *Prosopis juliflora, Tamarindus indica, Acacia farnesiana,* and to some extent the seeds of *Cassia fistula* and *Cassia grandis* also.

Anthribidae

Araecerus fasciculatus (DeGeer). Has been reared from palm seeds of various kinds, tamarind, *Caesalpinia sepiaria, Ceratonia siliqua, Ipomoea tuberculata,* climbing fig fruits, breadfruit and cotton bolls, also from dead dry sugar cane stalks and dead twigs.

Ptinidae

Mezium americanum Lap. Reared from sunflower heads and stored garden seeds.

Curculionidae

Anthonomus eugenii Cano. Infests fruits of garden peppers and *Solanum nodiflorum,* also eggplant fruits to some extent.

Cryptorhynchus mangiferae (Fab.). Lives in mango seeds, a high percentage of the seeds being destroyed.

Calendra oryzae (Linn.). Infests rice and corn.

Calendra linearis var. **striatus** (Thb.). Infests tamarind pods.

Sitophilus rugicollis (Casey). In India feeds in the seeds of *Shorea robusta* and *Dipterocarpus turbinatus.* Has been collected in Honolulu, but not reared.

Diacalandra taitense (Guer.). Sometimes occurs in the husk of the coconut, but usually bores in the bases of the leaf stems.

Scolytidae

Coccotrypes dactyliperda (Fab.). Feeds extensively in seeds of date palms and to some extent in seeds of other palms. Has been reared from the following: *Phoenix dactylifera, Livistona chinensis, L. rotundifolia, Oreodoxa regia, Washingtonia filifera* and *Pritchardia pacifica.*

Coccotrypes pygmaeus (Erich.). Has been reared from the seeds of the following palms: *Phoenix dactylifera, Livistona chinensis, Sabal palmetto, Sabal blackburniana, Cocothrinax argentea, Pritchardia thurstoni.* It has also been found infesting stored almonds.

A Day on Mt. Olympus

BY O. H. SWEZEY

(Presented at the meeting of April 4, 1935)

Mt. Olympus and vicinity was at one time my favorite collecting ground for insects of the native forest on the island of Oahu. It was accessible by the Castle trail which led up from Pauoa Flats to follow the main range along to Mt. Olympus and then down into Palolo Valley. Since this trail was closed to hikers in 1922, on account of being within a water reserve, I had not visited the region. Having recently complied with the necessary requirements for obtaining a pass to enter water reserves, Dr. Williams and I spent the day March 31 on a collecting trip up the ridge from Manoa Valley to the summit of Olympus, and on the main ridge in both directions from the peak. I was greatly interested to find that the collecting was as good as it used to be 13 years previously. I collected on the various kinds of trees and shrubs with the following results, over 50 species of insects being collected, or their presence noted:

SUTTONIA LESSERTIANA

Proterhinus excrucians Perkins was abundant in dead twigs. Six adults were collected, and in a bunch of dead twigs carried home for examination, 11 adults, 10 pupae and 11 larvae were found, also a parasite larva which matured 25 days later on as *Toxeuma* sp.

BROUSSAISIA ARGUTA

Proterhinus swezeyi Perkins. Two specimens were collected from dead twigs, not far from the place where the *type* of the species was obtained in 1917.

Proterhinus phyllobius Perkins. Seven specimens were collected from the leaves. Their mines were very abundant in the leaves.

Oodemas aenescens Boh. Six specimens were collected from dead twigs, and 1 specimen which seemed to be the var. *kahanae* Perkins.

The following were obtained by beating:

2 **small staphylinids.** Predacious bettles.

1 **Ilburnia sharpi** (Muir). Delphacid leafhopper.

2 **Leialoha ohiae** (Kirk.). Delphacid leafhopper. (Accidental, as it is attached to lehua.)

7 **Nesophrosyne** sp. Cicadellid leafhopper.

1 **Oliarus kaonohi** Kirk. Cixiid leafhopper.

7 **Eupelmus** sp. A male specimen and therefore undeterminable.

1 **Dolichopodid** fly.

KADUA CORDATA

Aristotelia sp. One larva in mine. Died before maturing.

PELEA ROTUNDIFOLIA

Opostega callosa Swezey. Mines of this small moth in the leaves.

PELEA WAWRAEANA (?)

Opostega serpentina Swezey. Four mines in leaves with about full-grown larvae which issued a few days later but died without making cocoons.

6 **Hevaheva perkinsi** Kirk. Orange psyllid on leaves without making galls.

1 **Nesophrosyne** sp. Cicadellid leafhopper.

METROSIDEROS POLYMORPHA

6 **Leialoha ohiae** (Kirk.). Delphacid leafhopper.

1 **Nitidulid** beetle.

BIDENS SP.

3 **Oodemas aenescens** Boh. Adults in hollow dead stems.

PRITCHARDIA MARTII

3 **Megatrioza palmicola** Crawf. Large psyllid on leaves.

Aspidiotus lataniae Sign. Scale insect on seeds.

FREYCINETIA ARBOREA

6 **Ilburnia halia** (Kirk.). A delphacid which oviposits in the leaves. Twenty-three egg-parasites, *Polynema ciliata* Perkins, were reared from leaves brought in.

Insects as follows were found at the bases of the leaves and in the wet debris accumulated there:

1 **Rhyncogonus koebelei** Perkins. Found in hiding by Dr. Williams.

Megalagrion asteliae (Perkins).

Megalagrion koelense (Blackb.). Nymphs of these two damselflies were collected by Dr. Williams. They are predacious on other insects.

1 **Metrarga contracta** Blackb. A predacious bug. Collected by Dr. Williams.

2 Small black mirid bugs.

4 **Metromenus palmae** Blackb. Carabid beetles. Predacious.

4 Undetermined staphylinid beetles.

4 **Eupetinus omalioides** (Sharp). Nitidulid beetle. Scavenger.

10 **Nesopetinus discedens** (Sharp). Nitidulid beetle. Scavenger.

CIBOTIUM CHAMISSOI

1 **Proterhinus longulus** Sharp. Feeds in dead frond stems.

4 **Proterhinus blackburni** Sharp. Feeds in dead frond stems.

Pentarthrum prolixum Sharp. Feeds in dead frond stems. Common.

A nitidulid beetle.

4 **Metromenus palmae** Blackb. In dead stems. Predacious.

1 **Dromoeolus cephalotes** (?). Found caught in spider's web.

GOULDIA SP.

3 **Oodemas aenescens** Boh. In dead twigs.

5 **Proterhinus excrucians** Perkins. In dead twigs.

1 **Mirid** bug. From the leaves.

1 **Leialoha ohiae** (Kirk.). (Accidental).

1 **Ilburnia** sp. Delphacid leafhopper.

1 **Eupelmus** sp. Undeterminable male.

SCAEVOLA GAUDICHAUDIANA

1 **Nesophrosyne** sp. Cicadellid leafhopper.

1 **Eupelmus axestops** Perkins. Swept from foliage. Parasite in *Banza* eggs.

SYZYGIUM SANDWICENSE

1 **Proterhinus deceptor** Perkins. In dead twigs.

1 **Toxeuma** sp. (?) Probably a parasite of the above.

1 **Aphaereta konae** Ashm. A parasite of Diptera.

BOEHMERIA STIPULARIS

1 Ilburnia sharpi (Muir). Delphacid leafhopper.

1 Nysius sp. A plant bug.

DUBAUTIA LAXA PSEUDOPLANTAGINEA

14 Aloha dubautiae (Kirk.). Delphacid leafhopper. Very numerous in all stages.

35 Polynema sp. A new species with rudimentary wings issued from leaves containing eggs of above.

24 Parectopa epibathra (?) Reared from mines in leaves which were very abundant.

22 Necremnus sp. (?) Issued from mines as a parasite of the above.

39 Secodella metallica (Ashm.). Issued from leafmines as a parasite of *Parectopa.*

1 Thrips.
A few yellow mycetophillid (?) larvae were in moisture at bases of leaves.

ACACIA KOA

Elimaea punctifera (Walker). Three eggs in a phyllode with exit holes of an egg-parasite, *Ufens elimaeae* Timb.

ELAPHOGLOSSUM GORGONEUM

Heteramphus swezeyi Perkins. Fronds were collected with 27 mines of this weevil. On examination April 3 results were as follows:

7 mines contained living *Heteramphus* larvae.
2 mines contained dead *Heteramphus* larvae.
13 mines had exit holes from which parasites had issued.
2 mines contained 3 adult parasites, *Secodella metallica* (Ashm.).
2 mines contained pupae of *Secodella.*
1 mine contained a parasite larva which matured April 20 as *Eupelmella subaptera* (Ashm.).

A parasitism of 66 percent.

Miscellaneous Observations on Maui

BY O. H. SWEZEY

(Presented at the meeting of April 4, 1935)

The following observations were made during a few days spent on Maui, Feb. 22-27, 1935.

Lathyrophthalmus aeneus (Scop.).

One specimen of this syrphid fly collected at Wailuku. First record on Maui.

Litomastix floridana (Ashm.).

Two specimens obtained by sweeping roadside weeds at Wailuku. First record of its occurrence on Maui. A parasite of *Plusia chalcites.*

Protaenasius sp.

Twelve specimens of this recently introduced mealybug parasite were obtained by sweeping roadside weeds at Wailuku. First record on Maui.

Chloridea obsoleta (Fab.).

Caterpillars of the corn earworm were quite common on the flower heads of a weed (*Heterotheca grandiflora*) in the sand hills at Wailuku.

Omiodes blackburni (Butl.).

The coconut leafroller was quite prevalent everywhere. At Wailuku its parasites, *Cremastus, Microbracon, Brachymeria* and *Trichogramma,* were quite abundant.

Adenoneura plicatum Walsm.

Adenoneura latifemoris Walsm.

In 31 pods of *Sophora chrysophylla* collected from a tree on Haleakala, 46% of the seeds were eaten by larvae of these two tortricid moths. The moths issued later.

Parectopa touchardiella Swezey.

Four specimens of this leafminer moth were reared from mines in leaves of *Touchardia latifolia* in Iao Valley.

Sybra alternans Wied.

Araecerus vieillardii (Montr.).

These two beetles were collected on pigeon peas in a school garden at Wailuku.

Xyleborus fornicatus Eich.

This scolytid was found very abundant in branches of an *Enterolobium cyclocarpum* tree which had been felled in Iao Valley.

Hesperobaenus capito (Fairm.).

This beetle was quite common under bark of the above tree.

Engytatus geniculatus Reuter.

This bug was quite abundant on *Heterotheca grandiflora* at Wailuku sand hills.

Dictyophorodelphax praedicta Brid.

This delphacid was collected on *Euphorbia* in Iao Valley.

Ilburnia mauiensis Muir.

This little green delphacid was collected on *Artemisia* in Iao Valley.

Kelisia eragrosticola Muir.

This delphacid was collected on *Eragrostis* in Iao Valley.

Nesosteles volcanicola Kirk.

This green cicadellid was collected on *Eragrostis* in Iao Valley.

New Distributional Records of Hawaiian Heteroptera

BY R. L. USINGER

(Presented at the meeting of September 5, 1935)

Nesomartis psammophila Kirk.

Apparently not recorded since its original description, except by Perkins in his Introduction to the Fauna Haw. Kirkaldy's Oahu and Hawaii (Kona Coast) specimens were taken by Perkins. As no type was indicated Perkins subsequently designated one from among cotypic material in his collection. This is now at the Bishop Museum. Specimens collected since this original material include five examples collected on *Eragrostis* at Milolii, Kauai, VIII-7-'25, and one example taken on the same host at Iao Valley, Maui, IX-11-'30, both collected by Mr. Swezey, and a single example taken by myself on *Sophora chrysophylla* above Humuula, Hawaii, VII-30-'35.

Reclada moesta White.

Described simply from the "Hawaiian Islands" by White in 1878. In Blackburn's collection at the Bishop Museum are two examples from Oahu and one from Kauai. In addition there is a fine series from Nihoa Island taken June 11-14, 1923, on bunch grass, *Pritchardia,* and *Euphorbia* by E. H. Bryan, Jr., C. M. Cooke, Jr., and D. Thaanum as well as two specimens taken by S. C. Ball at London, Christmas Island, XII-13-'24. China in the Heteropterous part of "Insects of Samoa,"[1] states in a footnote that his *Clerada minuta,* described from the island of Rodriguez near Madagascar, is identical with the Hawaiian species. Such a distribution is difficult to understand but further collecting may show this species to be widely distributed throughout the tropics as is the case with its relative, *Clerada apicicornis* Sign., to whose numerous locality records may now be added the Philippine Islands on the basis of two specimens collected by Pemberton at Los Baños in 1925.

Epelytes draptes Kirk.

This small lygaeid was described from a single specimen taken by Mr. Swezey on Kauai in 1908. It has since been taken at Kai-

[1] Pt. II, Fasc. 3, p. 127, 1930.

muki, Oahu, by both Swezey and Timberlake (1919) and again by Mr. Swezey at Kailua, Oahu, XI-20-'28. There is a specimen in the Perkins Collection at the Bishop Museum labeled "a late introduction, Honolulu, 1908".

BOOK NOTICES

BY R. L. USINGER

(Presented at the meeting of September 5, 1935)

Wigglesworth, Insect Physiology

Another of the excellent series of "Methuen's Monographs on Biological Subjects," Insect Physiology by V. B. Wigglesworth, pp. 1-134, 13 illustrations, Methuen & Co., Ltd., 36 Essex St., W. C. London, 1934, price 3s. 6d., provides us with the first general treatise on one of the principal fields of entomology. This small book brings together all of the general principles of physiology of insects, treating them under the following eight chapters: Integument, Respiration, The Circulatory System and Blood, Digestion, Excretion, Nutrition and Metabolism, Reproduction and Growth, and The Nervous System, Sense Organs and Behavior.

In order not to obscure the general physiological principles it was necessary to exclude "all that was special and non-essential and to retain only that material which best illustrated the general theme". As a consequence one finds, in reading the chapter on some "pet subject", that the endless details which make the subject so fascinating are not mentioned. However, the extensive bibliography of almost three hundred titles, "most of them recent works which will introduce the student to the earlier literature", makes it possible for the reader to pursue any particular subject as far as he desires.

Such a book has long been needed by workers in every branch of our science and we are especially fortunate that such a leading authority has seen fit to take time from his absorbing research to perform the equally important task of making his information available to the general worker.

Snodgrass, Insect Morphology

The Principles of Insect Morphology, pp. 1-667, 319 figs., 1935, McGraw-Hill Book Company, Inc., N. Y., price $6.00, is a detailed account of the morphology of insects interpreted in the light of embryology, anatomy, histology, palaeontology, and comparative morphology by one of the foremost authorities in this field in the world. R. E. Snodgrass is the author of many monumental works on morphology including his well-known "Anatomy and Physiology of the Honey Bee" and numerous papers on the morphology of various portions of the insect body published in the "Smithsonian Miscellaneous Collections". Written in characteristically readable style with a touch of the teleological point of view, the intricate structures and homologies of the parts of insects are marshalled before our eyes in an orderly and logical fashion. The function and method of functioning of each organ are given as well as the structure.

The material is arranged under nineteen chapter headings, the first being an introduction wherein insects are placed morphologically, and their relationship with other invertebrates pointed out. The second chapter, "General Organization and Development", gives a general view of embryological development with the ontogeny of each system. The remaining seventeen chapters are as follows: The Body Wall and its Derivatives; Body Regions, Sclerites, and Segmentation; Segmental Appendages of Arthropods; The Head; The Head Appendages; The Thorax; The Thoracic Legs; The Wings; The Abdomen; The Organs of Ingestion; The Alimentary Canal; The Organs of Distribution, Conservation and Elimination; The Respiratory System; The Nervous System; The Sense Organs; The Internal Organs of Reproduction; The Organs of Copulation and Oviposition.

Over three hundred remarkably clear and well chosen diagrammatic figures illustrate the text, greatly facilitating an understanding of the material presented. Other features include a glossary, at the end of each chapter, of terms applied to each part with their synonyms and, often, their German equivalents, a bibliography of twenty-one pages and an index of equal length.

An excellent lesson in the interrelationship of the various fields of entomology, this work calls upon many branches of our science in homologizing parts throughout the invertebrates. A terminology

is presented which conforms to the best modern usage. Homology of parts and a uniform terminology are certainly among the most important contributions of such a work. Fortunately they have been handled in masterful fashion due to the wide experience of the author and his familiarity with the literature. Students would do well to follow the conclusions and terms presented here, thus stabilizing our sadly confused anatomical terminology. Then later, if more exhaustive study shows that our ideas must be changed, uniformity may rightly give way to progress.

The Genus Geocoris in the Hawaiian Islands
(Lygaeidae, Hemiptera)

BY R. L. USINGER

(Presented at the meeting of November 7, 1935)

The genus *Geocoris* has not invaded insular areas to any great extent although it occurs in the Philippine Islands and on all mainland areas surrounding the Pacific. Other members of the great subfamily Geocorinae, however, have long been known from islands of Oceania where, in the Marquesas Islands, recent exploration has shown that *Germalus* reaches its peak, no less than seven species having been discovered there. The absence, until recently, of all members of the Geocorinae from the Hawaiian Islands has thus been a very remarkable thing. The first Hawaiian record of one of these "big-eyed bugs" was by Swezey (1936), based upon a specimen of *Geocoris punctipes* (Say) collected by him on *Cynodon dactylon* at Pearl City, Oahu, on Jan. 22, 1935. Two specimens have since been taken by Walter Donaghho on Ewa Coral Plain, Oahu, April 14, 1935 (see Swezey 1936). Recent collections by myself on the islands of Hawaii, Oahu, Manana, and Kauai are recorded in this paper and indicate that the genus has become firmly established here. It thus deserves a share of attention until its status as a beneficial or harmful group may be determined.

Proc. Haw. Ent. Soc., IX, No. 2, April, 1936.

GENUS GEOCORIS FALLEN, 1814

Short robust species, convex above. Head transverse, more than twice as broad, eyes included, as long; margin between eyes and antenniferous tubercles straight; tylus longitudinally sulcate; eyes scarcely or not at all stylate, extending postero-laterally beyond anterior angles of pronotum; ocelli small, two in number, located on the edge of depressions near the inner border of the eyes; bucculae very small but distinctly elevated. Antennae about as long as head and pronotum together, the first segment shortest and second segment longest. Rostrum attaining posterior coxae, first segment longer than second. Scutellum almost or quite as long as broad. Hemelytra either hyaline or opaque; clavus narrowed apically, scarcely surpassing tip of scutellum, the commissure wanting; corium with two slightly divergent rows of punctures near its inner margin, the row nearest the claval suture often dichotomous, a row at inner margin of embolium, and more or less scattered punctures on disk near apex.

Genotype, *Geocoris grylloides* (Linn.).

The principal literature is by Stål (1874), Distant (1903), Montandon (numerous papers over a period of years), McAtee (1914), and Barber (1935).

Germalus differs in the more elgonate form and flattened dorsal surface. The head is more than twice as broad, eyes included, as long; margin between eyes and antenniferous tubercles deeply sinuate; tylus not sulcate; eyes strongly stylate, produced laterally; ocelli located on vertex at margin of pedicels. Antennae considerably longer than head and pronotum together. Scutellum slightly broader than long. Clavus with sides parallel; commissure distinct, over half as long as scutellum. Corium with only three more or less distinct rows of punctures.

Two species of *Geocoris* are now known from our region.

1. **Geocoris punctipes** (Say), 1832.

A large, polished species rather uniformly light in color. Head in great part ochraceous or with fuscous to black markings, not at all granulous, with a fine longitudinal sulcus extending from sulcation of tylus onto vertex. A distinct, transverse, arcuate sulcus behind the tylus, not attaining eyes. Antero-lateral angles of pronotum rounded. Basal angles of scutellum with distinct, pale calloused areas. Hemelytra hyaline. Length 4-4.5 mm.

Oahu: Pearl City, I-22-'35, on *Cynodon dactylon,* O. H. Swezey, one specimen; Ewa Coral Plain, IV-14-'35, Walter Donaghho, two specimens; Mt. Olympus, 3,000 ft., X-6-'35, *Ilex sandwicensis,* R. L. Usinger, one specimen; and Manana or Rabbit Island, I-19-'36, R. L. Usinger, twenty-five specimens.

Found commonly throughout the southern and southwestern United States and Mexico and doubtless introduced through commerce from the Pacific Coast as suggested by the early records from the vicinity of Pearl Harbor. On Rabbit Island this species was very common, occurring on all types of vegetation and on the ground mainly beneath *Portulaca*. The shiny, green-gray nymphs are very striking in appearance and were common in all stages.

2. Geocoris pallens Stål, 1874.

Smaller, the head black, finely granular and beset with a short, sparse, white pubescence. Longitudinal and transverse sulci, except on tylus, obscure or wanting. Antero-lateral margins of pronotum distinctly angulated. Head, in great part, pronotum anteriorly and extending posteriorly behind the callosities, and scutellum at base and longitudinally at middle, black. Hemelytra opaque. Length, 3.5 mm.

Hawaii: Humuula, 6,000 ft., and south slope of Mauna Kea to summit, 13,784 ft., July 30 to August 11, 1935, R. L. Usinger; Mauna Kea, summit, on surface of snow, XII-28-'35, K. P. Chapson. Kauai: Barking Sands, XII-31-'35, R. L. Usinger.

A very common species in the western United States. On Hawaii it was taken commonly while collecting for the Hawaiian Academy of Science Mauna Kea Expedition at all elevations on this highest peak of the Hawaiian group. Here it occurred on the ground at the bases of tufts of grass and beneath stones in grassy fields. At Lake Waiau, 13,007 ft., it was one of the commonest insects, running about everywhere. A pair was taken in copulation on a tuft of grass above Lake Waiau, 13,050 ft. Mr. Chapson's record for midwinter on the surface of the snow where he found the bugs alive is remarkable. The occurrence of the same species at the other end of the Hawaiian Islands on Kauai is further evidence of its general distribution. It was found running about on the sand dunes beneath and about *Ipomoea* and *Vitex* plants in company with ants and a lowland species of *Nysius*.

Economic literature is replete with references on the biology of these insects. Almost without exception the early references condemn the bugs as destructive, often simply on the superficial evidence of their occurrence on a given plant. All recent records throughout the world, however, report them as predacious on eggs, nymphs, or even adults of mites, aphids, plant bugs, leafhoppers,

etc. Likewise the genus *Germalus,* if the action of *pacificus* in Fiji may be taken as typical, should be considered as predacious. H. W. Simmonds has noted it both in literature (1929) and in a recent letter to O. H. Swezey as predacious on the immature stages of the Lantana tingid, *Teleonemia lantanae* Dist., and on the eggs of the fruit fly, *Dacus passiflorae,* although it has also been taken on the berries of Lantana (Simmonds 1928). Many of the observations are so confusing that the evidence concerning the biology of the entire group is certainly not conclusive. It seems safe to conclude that *pallens* is predacious, at least on the top of Mauna Kea, for here there is little or nothing in the way of plant material available whereas there is an abundance of weakened insects which are continually being blown up to these bleak heights to die. Such a situation should offer a veritable paradise to predacious bugs which are able to withstand the adverse climatic conditions.

BIBLIOGRAPHY

Barber, H. G., Jl. N. Y. Ent. Soc., XLIII, pp. 131-137, 1935.

Distant, W. L., Fauna Brit. India, Rhyn., II, p. 29, 1903.

Fallen, C. F., Spec. Nov. Hemipt. Disp., p. 10, 1814.

McAtee, W. L., Proc. Biol. Soc. Wash., XXVII, pp. 125-136, 1914.

Say, Thomas, Heter. Hemipt. N. Am., New Harmony, Ind., p. 19, 1832.

Simmonds, H. W., Agric. Jl. Dept. Agric. Fiji, Vol. I, No. 1, p. 7, 1928.

Simmonds, H. W., Agric. Jl. Dept. Agric. Fiji, Vol. II, No. 1, pp. 36-39, 1929.

Stål, C., Enum. Hemipt., IV, pp. 133-137, 1874.

Swezey, O. H., Proc. Haw. Ent. Soc., IX, p. 125 and p. 130, 1936.

Insect Collecting on Lanai

BY R. L. USINGER

(Presented at the meeting of December 5, 1935)

The small island of Lanai, privately owned for many years, has remained but little known or explored entomologically due to the difficulties encountered in gaining access to it. First collected by the Rev. Thomas Blackburn for the brief period of one week in 1878, it has since been studied more carefully by Perkins during the winter of 1893-1894 and later, 1894 and 1896, for a period totalling four months, and by Giffard who made two trips for the purpose of collecting, one in 1907 and the other in 1917. Except for a certain amount of attention devoted by Illingworth and others to the economic pests of the pineapple fields this completes the collecting done on this island.

It was my privilege, in company with Mr. F. R. Fosberg of the University of Hawaii, to spend a week's time in collecting on Lanai. During this time Mr. George C. Munro and Mr. and Mrs. James Munro extended every possible courtesy to us. Their hospitality and genuine interest contributed in no small measure to the success of the trip and were greatly appreciated.

Considerable consternation was expressed by Mr. Giffard[1] at the condition of the native forest in 1907 and its danger of annihilation due to the depredations of goats, sheep, and cattle. It is true that lower parts of the mountains have suffered considerably on this score but, in general, the forest is much more extensive and in much better condition both in the high parts of the mountains, 2000 to 3400 ft., and in the upper portions of the valleys than at any time previously during the present century. This is largely due to the untiring efforts of Mr. George C. Munro, an ardent naturalist who, since 1910, has constantly been striving to protect and build up the native forest. This work has been carried on not only for aesthetic and biological reasons but also for the very practical purpose of insuring and protecting the water supply as well

[1] Giffard, W. M., Presidential Address on Insects of Lanai: Proc. Haw. Ent. Soc., I, pp. 176-184, 1908.

as for resistance to the very active wind erosion which, in some places, was literally blowing the island to sea. A rigorous campaign against the goats and sheep has been waged since about 1912 with the result that none of these animals were seen although I visited all of the principal regions of the Island which were of any interest entomologically. In addition the cattle have been fenced off so that the Island now supports several thriving patches of lowland dry forest on the northwest end of the plateau in the general vicinity of Kanepuu, Kapukaloa, and Keoneheehee. Forests of this type must once have been typical of the lowlands of all the islands but are now practically non-existent except on Lanai and Hawaii where dry forests of a slightly different type occur. Botanically these regions represent one of the most interesting elements of the entire Hawaiian flora but, unfortunately for the entomologist, the ants have wiped out what once may have been a considerable endemic insect fauna. At present the insect fauna of this region is dominated by ants, cockroaches of several species, and *Siphanta acuta* (Walk.). Other widespread or introduced species included several anobiids, psocids, the large carpenter bee, the sphingid moth *Herse cingulata* (Fabr.), *Coleotichus blackburniae* White, *Hyalopeplus pellucidus* (Stål), etc.

The dryness of the upland forest along the main ridge of the Island described by Perkins[1] was further substantiated by the very low yearly rainfall figures given by Wentworth[2] for the region. Evidently conditions have either changed considerably since Perkins' time or else we visited the island during a particularly wet season because the forest was found to be rather dense, quite wet, and often moss-covered, appearing quite typical of middle forest areas of any of the islands except for the absence of really high trees. Much of the actual moisture present condenses on the trees from the dense fog blown across from the northeast. This fog drip, as one discovers by camping overnight in the region, is a very important factor, amounting to an almost continuous dripping at times.

No attempt will be made to list all of the insects collected because many such captures were simply duplications of previous records. In general insects were as abundant as they are else-

[1] Perkins, R. C. L., Fauna Haw. Intro., p. xx, 1913.
[2] Wentworth, C. K., Geology of Lanai, B. P. Bishop Mus. Publ., Bull. 24, 1925.

where under similar conditions. The best trees for collecting were *Coprosma pubens, Metrosideros polymorpha, Straussia,* and *Gouldia terminalis* on the ridges, fern fronds and *Pipturus albidus* in the valleys and a low *Euphorbia* on the dry hillsides. The apparent absence of the previously reported *Plagithmysus* and *Metrarga* (this latter usually occurring in Ieie vines where a diligent search was made for it) was offset by the abundance of *Proterhinus* and nitidulid beetles and *Nysius* bugs. A new species of *Dictyophorodelphax* was taken on *Euphorbia.* It is closely related to the Oahu and Maui species and is found on the same host. *Reduviolus nubigenus* Kirk. was found commonly on Lehua along the ridge from Lanaihale to Haalelepaakai, the type locality being the latter station. The series of specimens taken exhibits striking sexual dimorphism, the males in every case having a ground color of mottled or spotted dark gray while the females are decidedly lighter with a ferrugineous ground color. The rather rare cymoid bug, *Sephora criniger* (White), was common on the broad green fronds of *Sadleria* and other ferns particularly along the stream bed in Kaiholena Gulch.

In conclusion it might be suggested that those interested in particular groups which require special methods of collecting will doubtless find a well-nigh virgin field here while others will find pleasure in rediscovering species which the early collectors predicted would soon be lost. Certainly Lanai, in its present state of preservation, offers a fertile and little explored field for insect collecting.

A Report on Some Heteroptera from the Hawaiian Islands, with Descriptions of New Species

BY E. P. VAN DUZEE

California Academy of Sciences, San Francisco, California

(Presented by O. H. Swezey at the meeting of December 5, 1935)

The material on which the present partial report is founded was kindly loaned to me by the Hawaiian Sugar Planters' Association and the Bishop Museum some time ago. It represents but a portion of the Heteropterous fauna of the islands but it contains some interesting forms including a few not previously known. Perhaps the most interesting genus is *Nysius* of which this collection contained many species. Of these I have worked out most of those already described but in the case of a number of the species more material and field work was needed. As there is a prospect of such field work being done soon it seemed best to return these *Nysius* for inclusion in a separate report on the results of that work, to be published later. The Miridae are in the hands of Dr. H. H. Knight of Ames, Iowa.

The types of the new species here described have been placed in the Bishop Museum.

FAMILY SCUTELLERIDAE

Coleotichus blackburniae White.

Kilauea (29 miles), 4,000 ft., Aug. 29, 1917 (Giffard); Crater Road, Kilauea, Hawaii, Sept. 13, 1919, 3,800 ft. (Giffard); Tantalus, Oahu, 1,600 ft., Nov. 22, 1908 (Giffard); Kaholuamanu, Kauai, May 10, 1920 (Kusche).

FAMILY CYDNIDAE

Geotomus pygmaeus Dallas.

Tantalus, Oahu, 1,300 ft., Oct. 15, 1905 (Giffard).

FAMILY PENTATOMIDAE

Oechalia patruelis (Stål).

The 60 specimens of this species exhibit all variations in color from the pale greyish of *grisea* to blackish fuscous and even metal-

lic green. They represent the following islands: Oahu, Hawaii and Kauai. Studies in the field may disclose two or more species in this complex. The name *grisea* Burmeister probably should be used for this species.

Oechalia virgula Van Duzee n. sp.

Size and aspect of *patruelis* Stål but at once distinguished by the rod-like styles of the male which are laterally flattened at apex. Length 10-12 mm.

Head square at apex with the angles rounded and the sides parallel to near the base, anteriorly with the narrow edges and four discal vittae pale, the median pair connivent at apex of tylus, the usual marking in the Hawaiian species but rather more prominent in this form. Humeri acute or subacute, about as in *patruelis*, more or less recurved. Apex of scutellum conspicuously pale and marked with two longitudinal rows of dark punctures, delimiting the smooth median line almost to the apex. Membrane smoky hyaline, darker at base, the nervures heavily marked with fuscous. Beneath pale, venter coarsely, sparsely fusco-punctate, the median area impunctate or nearly so; basal spine nearly or quite attaining anterior coxae, more or less recurved toward the apex. Legs rufous or rufotestaceous, the dark punctures almost obsolete. Surface above testaceous yellow, closely, coarsely punctate with black, the humeral area, base of scutellum and disk of the corium more or less blackish; narrow anterior margin of the pronotum, a line behind it, the latero-anterior margin before the sinus and the latero-posterior edge pale and calloused, the median line to the apex of the scutellum also pale. Styles of male straight, subterete, flattened laterally at apex. Basal plates of female produced on the median line, the apical margin sinuate on either side; surface tumid either side of the median line; valve short, rounded, with a thickened margin, lateral plates sinuate externally near apex; seventh segment scarcely exceeding the prominent tooth on the sixth.

Described from 15 males and 4 female examples.

Holotype, male, taken by W. M. Giffard at Puuwaawaa, N. Kona, Hawaii, at 3,700 ft., Aug. 25, 1917; allotype, female, taken by O. H. Swezey at Waiahole, Oahu, May 30, 1920; paratypes, 3 males taken with the holotype, six males taken at Kilauea, Hawaii, at 4,000 ft., Jan. 19, 1917 (W. M. Giffard), and one female taken at same place Aug. 5, 1919 (O. H. Swezey); two dark males taken in the Dry Forest, Hawaii, Jan. 1917 (Muir and Giffard); one female from Mt. Tantalus at 1,300 ft. (W. M. Giffard); one female from Alakai Swamp, Kauai, July 1917 (C. N. Forbes); one female from Kahuku, Kau, Hawaii, on "a-a" flows at 1,800 ft., May 29, 1918 (W. M. Giffard).

Oechalia pacifica (Stål).

Mr. Kirkaldy placed this as a synonym or mere variety of *patruelis* Stål which he synonymized with *grisea* Burmeister. Probably *patruelis* is a straight synonym of *grisea* but it is impossible to say positively that this is the case without a comparison of the types, so for the present I am using Stål's name *patruelis*, of the determination of which we can feel reasonably certain. *Pacifica*, however, is a quite distinct species. The shorter, more obtuse humeri will most quickly distinguish it. The length of the ventral spine varies in both species but in *pacifica* it is less curved, or more frequently quite straight. The male styles in *pacifica* have the apical margin broader, being drawn out into acute angles either side as viewed from behind, and the basal plates of the female are distinctly produced and subacute at the sutural apex, while these plates in *patruelis* are shorter and together roundedly arcuate across their whole apex; *pacifica* also averages darker in color and often has a distinct violaceous glint. All the Hawaiian species known to me have a small tooth below the humeral angles.

The 38 specimens before me represent the following islands: Oahu, Maui, Kauai and Lanai.

Oechalia kaonohi Kirkaldy.

Iao Valley, Maui, Aug. 8, 1918 (Swezey), 2 examples. This is a quite distinct species resembling *pacifica* but with even less prominent humeri.

Oechalia hirtipes Van Duzee n. sp.

Allied to *pacifica* and averaging as dark in color; ventral spine shorter; legs conspicuously clothed with bristly hairs; male styles strongly angled but with these angles not so much produced as in the allied species; basal plates of female longer, more produced at the suture. Length 10-13 mm. to tip of membrane.

Head broad at apex, the sides feebly sinuate; marked above as in the allied species with three impunctate vittae at base and apex, the median forked posteriorly and including the median basal vitta, thus showing five vittae medianly; smooth vitta near the eye broader than in *pacifica* and pale. Pronotal humeri usually more acute than in *pacifica*. Membrane of the elytra heavy and more contrasting. Beneath essentially as in *pacifica*, the ventral spine usually shorter, but little surpassing the intermediate coxae, and distinctly curved. Legs clothed with bristly hairs which are about as long as the diameter of the femora, these bristles becoming more sparse on the femora, especially anteriorly. Male styles sharply keeled below, more obtusely angled in *pacifica*, the lateral angles at the truncate apex not as

strongly produced. Basal plates of the female taken together more produced at apex, the acute inner angles in contact, not broadly rounded as in *patruelis*.

Color blackish castaneous, the pronotal apex rarely showing conspicuously pale, the humeral angles and vertex more or less blackish; median line of vertex sometimes paler and impunctate; sides of venter sometimes broadly black, the mesosternum black either side; hairs of legs pale.

Holotype, male and allotype, female, taken at Kilauea, Hawaii, Febr. 24, 1919, by Mr. O. H. Swezey. Paratypes, seven females, Kau Road, Hawaii, Jan. 16, 1919 (Muir and Giffard) 4 examples; Kilauea, Hawaii, June 18, 1918 (W. M. Giffard) 1 example; Kaholuamanu, Kauai, April 1920 (J. A. Kusche) 2 examples.

Like *pacifica* this is a deeply colored species but the humeri are rather more acute and the long bristly hairs on the legs as well as the form of the male styles will distinguish the species.

FAMILY COREIDAE

Liorhyssus hyalinus (Fabricius).

Kahala, Oahu, Febr. 18, 1917 (Giffard); Wailuku, Maui, March 1909 (Giffard); Kaena, Oahu, April 20, 1907 (Giffard); Kilauea, Hawaii, Dec. 10, 1911 (Giffard).

Ithamar hawaiiensis Kirk.

Oahu, March 25, 1917 (Giffard); Lanai, May 1908 (Giffard); "a-a" flow, Kau, Hawaii, 3,600 ft., Aug. 18, 1918 (Giffard); Kaena Coast, Oahu, April 20, 1907 (Giffard); Haleakala, Maui, Aug. 29, 1918 (Swezey).

This genus pertains to Stål's subfamily Rhopalida as the fourth tergal segment is sinuate before and deeply emgarinate behind. Kirkaldy placed it in what he called subfamily Coriscinae, or the family Alydidae of the Lethierry and Severin Catalogue and the subfamily Alydinae of Stål and most recent systematists. It is closely related to *Harmostes* Burm. but may be distinguished by the depressed clypeus, the shorter bucculae and the less expanded pronotal margins which are unarmed before.

Ithamar annectans Van Duzee n. sp.

Male. Proportionately shorter and broader than *hawaiiensis*, the head and pronotum being much the same as in *Corizus*. Head less produced behind the eyes with the ocelli on a line connecting the hind angles of the eyes, not distinctly behind such line as in *hawaiiensis*. Cheeks scarcely elevated

above the level of the tylus, arcuate at apex, produced in a short tooth in the type species; antennal segments as 10:28:28:20, in *hawaiiensis* as 15:28:-29:33. Pronotum shorter, its length is to its humeral width as 4:7, in the type species as 5:7. Scutellum as long as its basal width, in *hawaiiensis* a fourth longer. Membrane hyaline, nervures concolorous; corium with a large vague smoky cloud before the apex, otherwise hyaline with pale veins. Head and pronotum ochraceous with obscure dark lines on vertex and dots on pronotum forming four darker clouds on the hind margin of the latter; scutellum and clavus more or less dusky at base. Antennae and legs dotted with fuscous; hind femora dusky at apex and showing three faint transverse clouds; tergum black, margins pale, more widely so on segment VI. Length 7 mm.

Female stouter, tinged with red, especially on elytral veins, possibly indicating immaturity, the fuscous dotting less obvious and the smoky cloud on the corium scarcely indicated. Length 8 mm.

Holotype, male, taken at Iao Valley, Maui, Aug. 8, 1918; allotype, female, taken at Kuliouou, Oahu, Dec. 22, 1918, both by Mr. O. H. Swezey. With the holotype are a number of larvae taken at the same time and place that are obviously this species.

(NOTE: Besides the above there is a series of 7 specimens at the Bishop Museum collected by J. C. Bridwell, Nuuanu Pali, Oahu, June 28, 1917; and at the Experiment Station, H.S.P.A., 3 specimens, Waiahole, Oahu, June 12, 1921; one Haleauau Valley, Oahu, April 28, 1935; one nymph Olympus Ridge, Oahu, Jan. 12, 1936, collected by O. H. Swezey. All are from *Euphorbia*. This is the bug previously referred to as *"Ithamar* n. sp." Swezey, O. H., Proc. Haw. Ent. Soc., IV, p. 7 and p. 54, 1919; VI, p. 202, 1925.) [Ed.]

FAMILY LYGAEIDAE

Nesocymus calvus (White).

Tantalus, Oahu, 2,000 ft., Jan. 31 (Giffard); 23 miles, Olaa, Hawaii, 2,300 ft., Jan. 31, Sept. 9, 1919 (Giffard); Mt. Kaala, Oahu, July 22, 1917 (Bridwell).

Pseudocymus Van Duzee n. gen.

Near *Neocymus* but with rostrum not passing anterior coxae, and opaque, strongly punctured elytra. Head less produced, its width a third greater than its length; eyes prominent but not at all stylate; ocelli very small, their distance apart and from the eyes subequal; cheeks produced in minute acute teeth, scarcely attaining the apex of the tylus; surface of vertex somewhat convex, strongly punctate, these punctures omitting two broken longitudinal lines; antenniferous tubercles tumidly convex; antennae about

as long as the elytra, segments as 8:16:8:11, I much thickened, one-half the length of the head, IV less thickened, fusiform; rostrum attaining apex of anterior coxae, Seg. I subequal to II, attaining anterior line of eyes, IV shortest; pronotum nearly as long as its humeral width, sides parallel on posterior two-thirds, collum wanting, callosities smooth, elsewhere the surface strongly punctured; scutellum equilateral, median line smooth; corium moderately expanded, strongly punctured excepting the narrow smooth costa; membrane narrow, nervures wanting. Pleura strongly punctured; mesosternum punctate, not at all channeled; venter smooth, its median line villose.

Genotype, *Pseudocymus giffardi* n. sp.

This genus may be distinguished by its unusually short head and the strongly punctured fusiform elytra. The approximate ocelli allies it with genus *Nesomartis* Kirkaldy but the short rostrum and the characters of the antennae and elytra as well as the less prominent eyes will distinguish it.

Pseudocymus giffardi Van Duzee n. sp.

Fulvo-testaceous deepened on the pronotum anteriorly and on the head to rufo-testaceous or light castaneous; tip of rostrum and clavus black, membrane hyaline. Length 4-4½ mm.

Holotype, male, and allotype, female, taken October 29, 1916, at Nuuanu Pali, Oahu, by the late Mr. W. M. Giffard to whom this interesting insect is dedicated in recognition of the efficient work he did in making known the Hemipterous fauna of the Hawaiian Islands. Paratypes 2 males and 8 females, same data as the types and three males and one female taken by Mr. O. H. Swezey at Lanihuli, Oahu, May 25, 1919.

(Note.—This is the bug previously referred to as "*Nesocymus* sp. on *Eragrostis*." Bridwell, J. C., Proc. Haw. Ent. Soc., IV, pp. 281-282, 1920. Timberlake, P. H., Proc. Haw. Ent. Soc., IV, p. 325, 1920). [Ed.]

Metrarga contracta Blackburn.

Tantalus, Oahu, Aug. 12, 1906, 1,800 ft (Giffard).

Metrarga nuda White.

Moanalua, Oahu, 2,000 ft., Dec. 31, 1905 (Giffard); Tantalus, Oahu, 2,000 ft., Febr. 1, 1906 (Giffard); same place, 1,800 ft., June 11, 1906 (Giffard); same, 1,300 ft., Sept. 15, 1905 (Giffard); Iao Valley, Maui, Sept. 24, 1896 (Koebele). The latter specimen differs in having unicolorous elytra and in wanting the pale median pronotal line. Kirkaldy calls it var. *mauiensis* Kirk.

Metrarga villosa White.

Nuuanu Pali, Oahu, Oct. 19, 1919, Dec. 24, 1918; Kaiwiki, Hawaii, Sept. 22, 1918 (Swezey).

Nesomartis psammophila Kirk.

Kahala, Oahu, Jan. 30, 1917 (Giffard); Waianae Mts., Oahu, Nov. 9, 1919 (Swezey).

Clerada apicicornis Sign.

Tantalus, Oahu, 1,200 ft., April 15, 1906 (Giffard).

Reclada moesta White.

Nihoa Island, June 12, 1923, ex *Euphorbia* (E. H. Bryan).

Orthaea nigriceps (Dallas).

Tantalus, Oahu, Jan. 14, 1905; Nov. 24, 1903 (Giffard); Honolulu, Nov. 18, at light (Giffard); Lanai, 1,900 ft., Jan. 25, 1917 (Giffard); Keanae, Maui, July 4, 1920 (E. H. Bryan); Kokee, Kauai, Febr. 1919 (Kusche).

Orthaea vincta (Say).

Lihue, Kauai, Aug. 31, 1920 (Swezey); Honaunau, Hawaii, Aug. 13, 1919 (Swezey); Hilo, Hawaii, 1,500 ft., Aug. 3, 1901 (Giffard).

Sephora criniger (White).

Kaiholena, Lanai, Nov. 19, 1916 *Scaevola* (G. C. Munro); Kapano, Lanai, Nov. 27, 1916 (Giffard).

FAMILY TINGIDIDAE

Teleonemia lantanæ Dist.

Tantalus, Oahu, 1,300 ft., Jan. 8 and 29, 1905; April 16, 1905 (Giffard); Punchbowl, Oahu, Dec. 10, 1904 (Giffard); Nuuanu Pali, Oahu, Nov. 19, 1916; Kilauea, Hawaii, Jan. 25, 1916; Kahuku, Kau, Hawaii, Jan. 15, 1917.

FAMILY REDUVIIDAE

Empicoris rubromaculatus (Blackb.).

Kahuku, Kau, Hawaii, Jan. 15, 1917 (Giffard); Kilauea, Hawaii, Aug. 5, 1919 (Swezey); Dry Forest, Hawaii, Jan. 7, 1917 (Muir); Tantalus, Oahu, 1,300 ft., March 5, and April 11, 1905 (Giffard); Moanalua, Oahu, Febr. 8, 1920 (Swezey).

Empicoris whitei (White).

S. Kona, Hawaii, Aug. 16, 1919 (Swezey); Dry Forest, Kilauea, Hawaii, 4,000 ft., Jan. 9, 1919 (Giffard).

Zelus renardii Kol.

Honolulu, Dec. 16, 1904, Febr. 10, 1905 (Giffard); Kahuku, Kau, Hawaii, Jan. 15, 1917 (Giffard); Kau Road, Hawaii, Jan. 16, 1917 (Muir); Lanai, Oct. 19, 1907 (Giffard); Tantalus, 1,300 ft., Febr. 19, 1905 and Oct. 8, 1904 (Giffard).

FAMILY NABIDAE

Nabis capsiformis Germ.

Many examples of this common and widely distributed species were taken on the island of Hawaii and on Oahu, and it was also taken at 1,200 feet on the island of Maui.

Nabis blackburni White.

Nearly or quite as abundant as the preceding species and on the same islands and also on Kauai.

Nabis kahavalu (Kirk.).

Kahuku, Kau, Hawaii, Jan. 11, 1917 (Muir); Middle Puna, Hawaii, 750 ft., Aug. 16, 1918; Puuwaawaa, N. Kona, Hawaii, 3,700 ft., Aug. 14, 1917; Kilauea, Hawaii, 4,000 ft., Dry Forest, Hawaii, July 16, 1918; "a-a" flow, Kau, Hawaii, 4,000 ft., July 27, 1918 (Giffard).

This series also contains two aberrant males taken on the "a-a" flow, Kau, Hawaii, 3,600 ft., July 18, 1918, that differ from the typical form only in having a quite distinct male genital hook, its apical margin being oblique and its edge cut into a fringe of distinct teeth. This variation is certainly intraspecific with little if any significance, a less variation is common in related species.

Nabis giffardi Van Duzee n. sp.

Closely related to *kahavalu* (Kirk.), but fusco-maculate and with different male hooks. Length 8½ mm. to tip of elytra.

Structurally like *kahavalu* but with the antennae distinctly longer, the segments being as 8:12:11:7 while in Kirkaldy's species they are as 6:11:-11:6. Pronotum obviously shorter, the posterior lobe opaque and obscurely rugose-punctate; scutellum shorter, flatter, with the discal punctures almost obsolete; elytra slightly but obviously more opaque with heavy fuscous veins, the two veins of the median area approximate for most of their length, the

outer sending off one or two short branches exteriorly; apical veins crowded at apex of the median area; lower surface of head heavily white pubescent, in *kahavalu* with fewer and longer pale hairs. Male genital hooks closely twisted at base, the blade wanting the ventral notch as well as the dorsal notch just before the upturned point as found in *kahavalu*.

Color pale testaceous as in *kahavalu* with the following fuscous markings; narrow apex of segments I and II of antennae, tips of tibiae and tarsi, a subapical spot on the femora, the tylus, a cloud between the antennal base and the eye, a spot before the ocelli, a larger one behind the eye invading the base of the head, a trilobate spot on the pronotal collum, a five-lobed spot covering most of the posterior lobe of the pronotum, the scutellum, broad scutellar and commissural margins of the clavus, deepened in two spots on the median vein, a spot at base of radial vein, another on inner ulnar vein, two on apical margin of the corium, a cloud on the membrane and its veins, two spots on the disk of the tergum and one on the apical dorsal segment. Eyes reddish; lower face of antennal I faintly dotted.

Holotype, a male, taken by Mr. W. M. Giffard Aug. 22, 1907, on S. Kona Road, Hawaii, at 1,900 ft. Paratypes, two pale males same data. This form is too distinct from *kahavalu* to be considered a mere color variety. It has every indication of being a precinctive form.

Nabis tarai (Kirk.).

Haleakala, Maui, Aug. 25, 1918 (O. H. Swezey); "a-a" flow, Kau, Hawaii, 4,000 ft., July 27, 1919, one female. A series of 8 examples of the reddish form named *kaonohiula* by Kirkaldy were taken by Mr. Giffard from the same "a-a" flow at 3,600 ft. on July 13, 1912, Sept. 5, 1919, July 22, 1913 (on *Cyathodes*) and July 18, 1918 (on *Cyathodes*). Another female from N. Kau, Hawaii, Aug. 18, 1919 (Swezey), also belongs to this red form.

Nabis koelensis Blackb.

Kahuku, "a-a" flow, Kau, Hawaii, 1,800 ft., July 22, 1918, one male; Kahala, Oahu, Febr. 18, 1917, one female.

Nabis truculentus (Kirk.).

Tantalus, Oahu, 1,300 ft., April 1, 1906, one male; Maunawili, Oahu, 800 ft., Febr. 23, 1905 (labelled "co-type G. W. K., Fauna Haw."), one adult and two young.

Nabis subrufus White.

Tantalus, Oahu, 1,300 ft., Febr. 19, 1905 (labelled *"subrufus"* as determined by Kirkaldy); Kahuku, Kau, Hawaii, Jan. 15, 1917; Kilauea, 29 miles, Jan. 8, 9, 14, 21, 1917; Olaa, Hawaii, 27

miles, 3,600 ft., July 30, 1918; Kilauea, 29 miles, 4,000 ft., Aug. 21, 1917, July 9, 1912, June 9, 1911, July 19, 1918 (lumber camp); steam crack, Kilauea, Hawaii, 3,800 ft., Sept. 6, 1919; Olaa, Hawaii, 27 miles, 2,300 ft., Sept. 9, 1919, Aug. 1913; Glenwood, Hawaii, Jan. 1917; Lanihuli, Oahu, May 26, 1919 (Swezey); Kaiwiki, Hawaii, Sept. 22, 1918 (Swezey); Kaumuahona, Oahu, Jan. 12, 1919 (Swezey). This is a long series showing the usual variation.

Nabis lusciosus White.

This long series includes one labelled *lusciosus* on Kirkaldy's authority. It represents the islands of Kauai, Oahu, Maui and Hawaii. It shows much variation in size, the smaller ones being no larger than *pele*. However, the blade of the male hook is broader with the inflexed lower surface more expanded.

Nabis pele (Kirk.).

Kilauea, Hawaii, June 9, 1911. The unique male is undoubtedly correctly placed here. There is a female without data determined by Kirkaldy in the Bishop Museum material.

FAMILY ANTHOCORIDAE

Lasiochilus denigratus (White).

Glenwood, Hawaii, March 2, 1919 (Swezey), two adults and two nymphs.

Physopleurella mundula (White).

Hookena, Hawaii, Aug. 18, 1919 (Swezey), one specimen.

Triphleps persequens White.

Wailuku, Maui, May 15-16, 1918 (Giffard and Fullaway); Honuapo, Kau, Hawaii, July 31, 1918, ex Naio (Giffard); Kahuku, Kau, Hawaii, "a-a" flow at 1,800 ft. (Giffard); Honaunau, Hawaii, Aug. 13, 1919 (Swezey); Tantalus, Oahu, 2,000 ft., Oct. 12, 1919 (Giffard).

Xylocoris discalis Van Duzee.

Honolulu, Dec. 29, 1921 (S. Bickerton), one example. This must have been a recent importation from southern California.

FAMILY VELIIDAE

Microvelia vagans White.

Waianae, Oahu, Febr. 29, 1920 (E. H. Bryan); Tantalus, Oahu, 1,300 ft., Dec. 23, 1905 (Giffard); Malamalama, Oahu, Nov. 30, 1919 (E. H. Bryan).

FAMILY SALDIDAE

Saldula exulans (White).

Molokai, 1,300 ft. (Giffard); Honomanu, Maui, June 23, 1920 (Bryan).

Saldula humifera (Kirk.).

Haipuaena, Maui, June 30, 1920 (Bryan); Alakai Swamp, Kauai, July 1917 (C. N. Forbes).

Saldula oahuensis (Blackb.).

Olaa, 23 miles, Hawaii, 2,300 ft., Aug. 8, 1918 (Giffard); Glenwood, Olaa, Hawaii, Sept. 3, 1917 (Giffard); Tantalus, Oahu, 1,300 ft., Febr. 25, 1906 (Giffard); Kokee, Kauai, Febr. 1919 (J. A. Kusche).

Saldula procellaris (Kirk.).

Palolo, Oahu, Feb. 26, 1922, 4 specimens (O. H. Swezey).

A New Species of Pyrophorus (Coleoptera, fam. Elateridae) From Guatemala, Recently Introduced into Hawaii

BY R. H. VAN ZWALUWENBERG

(Presented at the meeting of July 11, 1935)

George C. Champion in the Biologia Centrali-Americana (Coleoptera, vol. 3, pt. 1, p. 464, 1897) stated that: "No Pyrophorus has been noticed as yet on the Pacific slope of Guatemala." This seeming lack of a genus usually conspicuous in the habitat where it occurs, can now be filled by a species, apparently new and unusually secretive in its adult habits, recently found by Mr. F. A. Bianchi near Escuintla, Guatemala, some 30 miles inland from the Pacific coast, on the lower edge of the coffee belt, at an elevation of about 1,100 feet.

Pyrophorus bellamyi n. sp.

Twenty-two to 31 mm. long. Piceous to dark rufous; covered with fine, recumbent, tawny pubescence somewhat modifying the basic color of the insect. Front excavate; coarsely punctate. Antennae not quite attaining the tips of the posterior angles of the prothorax in the female, or exceeding the tips by about one segment in the male; 3rd joint slightly longer than the 2nd, the two together shorter than the 4th; 4th longer than any of the succeeding joints except the terminal one; joints 4-10 more or less serrate, especially in the male, not quite twice as long as wide; terminal joint with a false segment, more pronounced in the male than in the female.

Prothorax about as long as wide; its upper surface coarsely and closely, but not umbilicately, punctate; more sparsely so on disc; a vague median impunctate line running sometimes the full length of the pronotum. Prothorax strongly rounded on the sides in the female, less so in the male; the posterior angles moderately divergent, feebly unicarinate; luminous vesicles nearer the lateral than the posterior margin, suboval, well-defined, not prominent; a small median tubercle at the base of the pronotum, more acute and conical in the female, less prominent in the male.

Scutellum coarsely punctate, roughly pentagonal, more or less flattened on the posterior half, with the posterior angle rather prominent.

Elytra slightly wider at base than the prothorax (female) or as wide (male); sides parallel for about two-thirds their length (female), or narrowed from the humeri (males); apex conjointly rounded, with sutural angle finely mucronate in most specimens. Striae consisting of rows of rather coarse, deeply impressed punctures; intervals coarsely punctulate, especially toward the base.

Underside with coarse, closely placed punctations, becoming much finer on the abdomen. The luminous vescicles plainly visible from below, where they are more extensive than on the pronotal surface. The sides of the mucral cavity are sub-horizontal posteriorly, but are not prominent.

Aedeagus (fig. 1) very similar to that of *P. radians* Champion, but with the outer sides of the lateral lobes more sloping and less abruptly rounded than in that species.

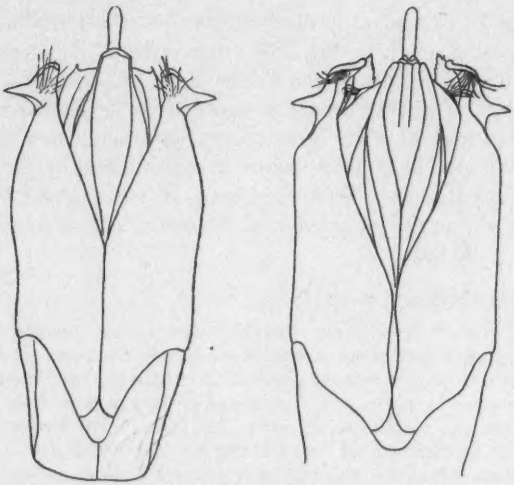

Fig. 1. At left, *Pyrophorus bellamyi*, aedeagus.
At right, *Pyrophorus radians*, aedeagus.

Described from six specimens (females): 1 specimen (allotype), El Salto, Escuintla, Guatemala, reared, March 1935, F. A. Bianchi and F. X. Williams; 1 specimen, same locality, reared, March 1933, F. A. Bianchi; 2 specimens, same locality, reared, April, 1933, F. A. Bianchi; (males): 1 specimen (holotype) same locality, reared, April 17, 1933, F. A. Bianchi; 1 specimen, reared in Honolulu, from larva collected at El Salto, May 1935, F. A. Bianchi and F. X. Williams. The type material is in the type collection of the Hawaiian Entomological Society.

Named in appreciation of the assistance given Messrs. Bianchi and Williams in their work for the Experiment Station of the Hawaiian Sugar Planters' Association, by Mr. J. C. Bellamy, the manager of El Salto plantation.

This species runs in Champion's table (l. c., p. 465) to *P. physoderus* Germar, from which it can be separated by its more convex and robust form, and by its coarser punctation; in addition, Hyslop has shown[1] that the true *physoderus,* as well as his *atlanticus,* has no pronotal tubercle in front of the scutellum. As for Hyslop's other two North American species, *arizonicus* has the aedeagus distinctly different from that of *bellamyi,* while that of *texanus,* although similar to that of the species here described, has the median lobe much wider in proportion to its length. Furthermore, in *texanus* the luminous vescicles are as near to the posterior margin of the pronotum as to the lateral margins, whereas in *bellamyi* they are plainly nearer the lateral margin.

From *radians* the present species can be separated by its coarser punctation throughout, and especially by the structure of the mucral cavity; in *bellamyi,* although the sides of the cavity are sub-horizontal posteriorly, they are not prominent, whereas in *radians*[2] they are horizontal and definitely outstanding at the rear, then incline suddenly forward. I have not seen specimens of *stella* Candèze, but the aedeagus, as figured by Champion,[3] is distinct from that of *bellamyi.*

Pyrophorus bellamyi was introduced into the Hawaiian Islands from the vicinity of Escuintla, Guatemala, by Messrs. Bianchi and Williams in 1934 and 1935, as an addition to the natural enemies of white grubs in these Islands. A total of 446 living Pyrophorus larvae were received from them in Honolulu between June 1934 and April 1935. From these have been reared to date, some 150 adults, which, after mating, were released in sugar cane fields in the Pearl Harbor district and in Manoa valley on Oahu. In addition, some 1,000 second-generation larvae, hatched in the laboratory, were also released in the same localities.

Mr. Bianchi and Dr. Williams state that Pyrophorus was unknown to residents in the vicinity of Escuintla prior to its discovery in 1933, and that during their stay of some two years in that region, they never observed Pyrophorus adults in flight, either by day or by night. In fact the only adult of *P. bellamyi* obtained other than by rearing from larvae, was one taken by Dr. Wil-

[1] Proceedings Entomological Society of Washington, vol. 19, pp. 2-12, 1917.

[2] Through the courtesy of the officials of the British Museum I have seen both sexes of *radians,* identified by Champion, from Vera Cruz.

[3] Biologia Centrali-Americana, Coleoptera, vol. 3, pt. 1, pl. 20, fig. 32, 1897.

liams at El Salto on the morning of June 16, on the young terminal growth of a glandular composite, apparently allied to Helianthus, where it occurred in company with other adult elaterid species (among them *Aptopus vicinus* Champion), meliponine bees, honeybees, *Campsomeris tolteca* (Saussure), etc. Adults of *P. radians,* on the other hand, they found, during a brief visit to eastern Guatemala, flying commonly at night, and conspicuous by reason of their luminescence. The predacious larvae of *bellamyi* were found at Escuintla at comparatively shallow depths, often in dust-dry soil.

Biological Studies in Hawaiian Water-Loving Insects

PART I
Coleoptera or Beetles

PART II
Odonata or Dragonflies

BY FRANCIS X. WILLIAMS

(Presented at the meeting of Dec. 5, 1935)

FOREWORD

This work was done at intervals, as opportunity offered, during the past six years and concerns chiefly the Island of Oahu, on which is the city of Honolulu. Numerous excursions into the field were made. Some of these were incidental to Experiment Station business. Very scant observations were made on the Island of Kauai, and hardly more, on the Island of Maui. A certain amount of data were obtained from the lowlands of Molokai, while late in 1933, the writer was fortunate in being able to spend a week at the Puuohoku Ranch, at the eastern end of that island and, in company with his brother, engaged in engineering work, to penetrate well into the rugged mountains and explore stream and waterfall. On the large Island of Hawaii, with an area of 4,015 square miles and mountains rising to nearly 14,000 feet, observations on water-loving insects were made in various scattered localities, and more at length and in detail when in the fall of 1931, in company with Mr. O. H. Swezey, about a week was spent at the forest nursery at Nauhi Gulch, at an elevation of 5,200 feet on the slopes of Mauna Kea, the summit of which, altitude 13,784 feet, was also visited.

Thanks are due to Mr. O. H. Swezey for assistance both in the field and in the laboratory; to Mr. E. H. Bryan, Jr., for identifying various Diptera; to Dr. H. L. Lyon for determining plants, chiefly aquatic and subaquatic; and to Mr. Twigg-Smith, illustrator for the Experiment Station, H.S.P.A., and to his assistant, Mr. J. Yamamoto, for a very considerable amount of illustrative

work. The writer is indebted also to other gentlemen outside of the Territory of Hawaii, for which acknowledgment is made in the proper places in the text. The "Fauna Hawaiiensis," by various authors, but chiefly those parts by Dr. R. C. L. Perkins, who spent years in the Islands collecting and studying the material for the "Fauna," has proved invaluable. I have also gained much information from the two excellent books—"Dragonflies of North America" (1929), by Needham and Heywood, and "Biology of Dragonflies" (1917) by Tillyard. No attempt has been made to do justice to the immense amount of literature on aquatic and semi-aquatic insects.

Part I deals with 7 species of beetles that spend a considerable part of their existence in the water. Part II is less complete, as only about half of the 30 species of dragonflies are dealt with at any length. The flies or Diptera, the bugs or Hemiptera and the single species of Lepidoptera, *Nymphula fluctuosalis* Zell., the caterpillar of which is aquatic, are being worked up and, it is hoped, will appear in good time.

The writer is not a specialist in any of these groups and he has endeavored to deal with the subject mainly from a biological standpoint, leaving alone as far as possible, questions of phylogeny and taxonomy.

INTRODUCTION

The Hawaiian Islands arising as volcanoes from the sea and exceedingly remote from the nearest large land mass, received through the course of ages the chance insect migrants that have evolved into the highly interesting though naturally rather unrepresentative entomological fauna of today. Unrepresentative, in that where a section of an average continental fauna has the major groups—orders and families—of insects reasonably well represented, in Hawaii with its oceanic fauna, certain of these major groups are entirely lacking—at least as native insects—others may be barely present, or be represented frequently by few genera with a large number of species.

Water-loving insects are not a rich group in the Hawaiian Archipelago. Here are no may-flies (Ephemerida), no stone flies (Plecoptera), no caddis flies (Trichoptera), nor any aquatic Neuroptera although conditions for their existence seem favorable. The beetles and bugs are few in number and generally of no great

interest, the moth, the caterpillar of which is a rice pest in parts of the Orient, is adventitious here. The flies though rather indifferently represented and not very well known are of considerable interest, certain ones, as species of Chironomidae and Dolichopodidae being adapted to special environment. It is in the Odonata, suborder Zygoptera or damselflies that we find the greatest development among our aquatic insects; in fact some of these have ceased to be truly aquatic in their nymphal stages, the forested ridges on which they live often being devoid of streams and pools. Those damselfly nymphs that live in the water usually favor a certain environment there and from the most aquatic to the terrestrial species of nymphs there exists a pretty good series of intermediate forms connecting the one with the other.

To gain a fair knowledge of which Hawaiian insects spend all or part of their existence in or on the water, bogs, puddles, ponds, reservoirs, ditches, flumes, clear mountain streams with their wet banks and waterfalls, foul-smelling waters of the lowlands, maritime marshes, the sea itself, tree and rock holes containing water, water at the leaf bases of plants, dense fern cover—all must be investigated. Even sewage should not be exempt from search. It may be pleasanter of course, and generally more profitable to work the more upland districts for, quite apart from matters of shade and more aesthetic surroundings, the water-loving insects of mountains and canyons are chiefly endemic (native), they exist in greater variety there and often show remarkable adaptation to their environment. In the lowlands nevertheless, there is much of interest in and about water. The following is a mere sketch of the environmental distribution of our water-loving insects. It will be noted that the life zones are not always well defined and that a number of the insects range from sea-level to waters more than a mile above it. Moreover, the same species may inhabit both fresh and brackish water.

The bather at Waikiki, Honolulu, may have observed the wingless, salt water strider bug, *Halobates sericeus* Esch. as it races over the surface of calm waters at his approach, or at rare intervals, when it is beached in numbers during rough inshore weather.

About wet sand, rocks and splash pools of the seashore occur a few flies of the families Ephydridae, Canacidae and Dolichopodidae, as well as two marine midges (Chironomidae *sens. lat.*)

recently brought to light. Rusty red mites (acari) and tiny collembolous insects explore the rocks by the sea.

One often finds just behind the beach, shallow brackish ponds evaporated to a salinity even exceeding that of sea water and set in an area of the succulent Pickle weed or *akulikuli kai, Batis maritima* Linn. Here despite small minnows the prettily mottled water boatman bug, *Trichocorixa blackburni* (White) is to be seen in all stages. Its eggs, small and whitish, are glued to submerged objects and may be conspicuous on the erect little *Potamogeton* seedling plants, hardly thicker than a thread. Rarely was *Trichocorixa* found in mountain waters. Common on dirty brown felt-like mats of blue-green algae, chiefly *Phormidium* sp. but with small numbers of *Lyngbya* and *Anabaena,* is the little spotted wing *Scatella sexnotata* Cresson fly as well as a borborid fly, *Leptocera* sp. The large pale gray dolichopodid fly *Hydrophorus pacificus* Van Duzee and the little hydrophilid beetle *Enochrus nebulosus* (Say) frequent brackish as well as quite fresh lowland waters. Passing now to shallow maritime marshes where the water is less brackish to quite fresh, to old rice fields, taro patches, lowland reservoirs, rain pools, etc., we note a considerable increase in the aquatic fauna. Here and there near the water's edge one often sees the rather large predacious anthomyid fly, *Lispa metatarsalis* Thomson resting or moving about in an alert manner. Its larva, likewise predacious, is semiaquatic or even aquatic under certain conditions. The insect however, occurs also beside little streams in mountain forests. The far-ranging *Brachydeutera hebes* Cres., a large ephydrid fly is now conspicuous. *Scatella* may occur in swarms, and *Hydrophorus* is numerous. The night mosquito *Culex quinquefasciatus* Say is in this environment as well as at considerable altitudes while the mosquito-like *Chironomus hawaiiensis* Grims. is one of the most abundant lowland insects in fresh water, its bloodworm larva on muddy bottoms or in thick growths of green algae serving as food for more powerful aquatic insects. Along muddy shores a little carabid beetle (*Bembidion niloticum batesi* Ptz.)[1] is often abundant. About weedy and sometimes malodorous shallows we find the *Enochrus* beetle plentiful, and often its distant relative, the larger very convex black *Coelostoma fabricii* (Montr.) in smaller numbers. Both are foreign insects. Here too may occur

[1] Determined by Dr. E. C. Van Dyke.

the tiny dytiscid beetle *Hydrovatus confertus* Sharp, while its larger relative *Rhantus pacificus* (Bdv.) prefers deeper and more open waters from near the shore to far into the cool uplands. The two widely distributed dragonflies *Anax junius* Drury and *Pantala flavescens* (Fab.) breed here, their empty nymphal shells being often found clinging to reeds and to *Herpestis* plants. The black-marked *Tramea lacerata* Hagen dragonfly, also exotic, is less plentiful. Its nymphs have been taken in lowland plantation reservoirs where lives also the native damselfly, *Megalagrion xanthomelas* (Selys). The back-swimming water bug *Buenoa pallipes* (Fab.) belongs more properly to these lowlands but is found also in canyon pools. The three little water-running bugs: *Mesovelia mulsanti* White, *Merragata hebroides* White, and *Microvelia vagans* (White) may all be present on one body of water; the first species, recently noted here, seems altogether a lowland insect, the second is essentially so, while *Microvelia* appears equally at home in the lowlands as it does a mile or more above the level of the sea.

In these sun-heated, often stagnant and shallow lowland waters, frequently matted with algae and occasionally ill-smelling with decaying vegetation, tiny organisms—the Protozoa or one-celled animals, Rotifera, the bryozoan *Plumatella,* various, usually small worms or vermes, the minute Crustacea (the clam-like Ostracoda, the swift-darting Copepoda, and the clouds of Cladocera)—all may exist in countless numbers. Probably most or all of these together with the prolific *Chironomus* bloodworm serve as food for the aquatic young of many insects and for some insects throughout their life.

In malodorous or in sewage waters we find the rat-tailed maggots *Lathryophthalmus arvorum* (Fabr.) that produce shrill-humming, bee-like flies, and Psychodidae or moth flies. Here too the viviparous snail *Melania* may be exceedingly abundant.

This exuberance of water life however is often of brief duration. The struggle for existence is usually severe, and where mosquito fish—top minnows or killifish—gain entrance, as they eventually do in most lowland waters, the invertebrate fauna suffers accordingly. And here a swamp dries up for the season or for longer, and there a reservoir is drained. Pools becoming smaller and smaller ever crowd their diverse tenants, an orgy of feasting and cannibalism results; some of the forms survive to com-

plete their transformations but many others perish miserably in the sun-baked mud. With the return of the waters, aquatic life must commence anew.

In the moister forests and uplands, the streams, the bogs, the several plant species that conserve moisture in their leaf axils, as well as the moss-like growth and the wet trash beneath the undercover—all these being in a region of greater rainfall and shade and often less disturbed by man, support in better equilibrium a modest though interesting water-loving fauna. A large number of dolichopodid flies of the genus *Campsicnemus* occur in damp places in the mountains and are often found skating on pools there. A fewer very active species perform regularly on gently running water. Other *Dolichopodidae* such as the large *Dolichopus exsul* Aldrich frequent wet banks and water margins and at least one species may breed at the leaf axils of plants. *Brachydeutera hebes* is still with us, patronizing stagnant pools and occasionally breeding in a tree hole along with the common day mosquito, *Aedes albopictus* (Skuse) and the large moth fly, *Telmatoscopus albipunctatus* (Will.). *Scatella* flies of more than one species frequent wet rocks and also mountain flumes and ditches. The larva of *Scatella* developing, not or barely awash among algae and diatomaceous growth, are sought by a slow-moving little figitid wasp that parasitizes it. *Tanytarsus lacteiclavus* Grims., a small pale green midge hovers in lazy swarms over the water, its tube-constructing larva dwelling therein. A very few ceratopogonid midges are aquatic or subaquatic here, the larvae of other midges breeding in the mossy forest at greater altitudes in the leaf axils of certain plants[2] and among damp moss and debris. The curious dusky midges of the genus *Telmatogeton* (= *Charadromyia*) frequent torrents, waterfalls and swift ditch and flume waters, which they sometimes follow to low levels. The long-legged limnobiid flies have subaquatic species that in their early stages dwell on dripping wet banks or among old water-soaked leaves. Three water beetles—*Rhantus, Copelatus* and *Limnoxenus*—are more characteristic of the uplands where they are often found in the little disconnected pools that constitute the very headwaters of streams. The mountain dragon-

[2] When the *ieie* vine (*Freycinetia arborea* Gaud.) is in fruit, the wet pasty material at the base of the cones that are embraced cup-like by the short and rather widely spreading red leaf bracts, may be periodically covered by rain water. Thus is its chiefly dipterous fauna adapted to a subaquatic life.

fly, *Nesogonia blackburni* (McLachl.) and the giant *Anax strenuus* Hagen are more properly upland species. Nearly all the zygopterous Odonata or damselflies are forest insects and are of the greatest interest. The small, water-running bug *Microvelia vagans,* so destructive to *Tanytarsus* midges, as these delicate insects are emerging from the water, is everywhere abundant on mountain waters to an altitude of at least a mile.

Streams of the uplands are subject to certain vicissitudes, and thus is their fauna affected favorably or otherwise. With one of the little streams behind Honolulu in mind, changes may occur somewhat as follows: During dry periods, the waters considerably diminished in their upper reaches, separate into little pools or remain connected one with the other by a very thin flow. Pools thus rendered stagnant favor an abundant growth of filamentous green algae such as *Cladophora,* and here certain of the Nematocera or lower flies may breed extensively and so too, their enemies. The region abounds in the small trees of the common guava (*Psidium guajava* Linn.) the large yellow fruits of which seasonally litter certain trails and befoul pools, thus creating suitable habitats for the rat-tailed maggot which is the larva of the large bee-like syrphid fly (*Lathryophthalmus arvorum* (Fab.). *Culex* and *Brachydeutera* will also breed here. The decaying guavas along the forest paths are often reddish brown with countless numbers of the common pomace fly, *Drosophila melanogaster* Meigen, that through force of circumstances may occasionally be subaquatic in the immature stages. On the well tenanted pools may be crowds of the *Microvelia* bug, while along the margin or among dense algae is the savage larva of the *Limnoxenus* water beetle and perhaps an occasional larva of a dolichopodid fly. In its depth may be the nymph of the mountain dragonfly *Nesogonia,* and perhaps of two or three damselflies. In time, the succulent trailing weed "honohono" or *Commelina nudiflora* Linn. grows very rankly, sometimes choking up large portions of the stream bed and thus quite concealing the water. But when the rains commence, pools unite as the stream swells and finally, after one or two heavy downpours, the invading vegetation is swept aside, boulders may be shifted and debris taken away or deposited so that the stream fauna suffers.

Inhabiting mountain streams, even above large waterfalls, are the little native shrimp (*Atya bisulcata* Randall) and one or more

species of gobies or *oopu*. The shrimp seems harmless to insect life but the gobyfish devours quantities of the larvae of chironomid midges and other organisms.[1] Trout have been introduced into streams on the Island of Kauai. The trout is a voracious feeder on aquatic insects, and in New Zealand where it was brought in years ago, it has nearly exterminated certain water insects there.

Aquatic snails common in the lowlands may also be plentiful in mountain streams. A very tiny species somewhat like a limpet in form of shell is *Ancylus sharpi* Sykes[2] that clings almost scale-like to submerged stones and dead leaves in water.

In collecting aquatic insects for live study it is often sufficient to bring them to the home or laboratory in water-soaked green algae, decayed leaves or moss. In such media they will be less likely to attack one another than in a jar of water only. The larvae and pupae of Chironomidae are best transported in open containers with water supplied with algae. These insects require well aerated water.

The aquarium in which organisms are to be studied, or a stock kept, may range from a small dish to a vessel holding many gallons. Comparatively shallow containers with vertical sides are more generally suitable. As far as possible natural conditions should be simulated, the object being to satisfy the inmates of the vessel rather than the spectators. The goldfish bowl complex

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[1] The alimentary tracts of three specimens of a goby collected in streams behind Honolulu were examined, with results as follows:

Goby No. 1. From Hering Valley, Makiki, elevation about 1,000 feet, May, 1933. Length, 5 11/16 inches.
Mollusca: many quite small *Lymnaea*-like snails, 1 *Ancylus sharpi* Sykes. Crustacea: 1 Ostracoda, many Copepoda. Insecta: Diptera; a few nematocerous larvae including 1 limnobiid, *Tanytarsus*, and 2 *Tanytarsus* pupae; Odonata, 1 small *Megalagrion* nymph and remains of others; Thysanoptera, 1 thrips. Arachnida: 3 mites. In addition, much undetermined fine organic matter, the waffle-like squares of diatomaceous plants, filamentous green algae and some stellate leaf hairs.

Goby No. 2. Same locality and date as No. 1. Length about 2 10/16 inches.
Insecta: Diptera; Chironomidae; a considerable number of larvae of *Tanytarsus*. Much undetermined fine organic matter. The bulk of the recognizable material consisted of waffle-like Diatomaceae.

Goby No. 3. Upper Manoa Valley, January 26, 1936. Length about 7 inches.
Crustacea: Portions of one or more Isopoda, moulted (?) portions of the *Atya* shrimp. Myriapoda: A small milliped (*Aporodesminus*, probably *wallacei* Silvestri). Arachnida: 1 mite. Insecta: 1 limnobiid larva; Odonata, 1 nymph of *Megalagrion oceanicum*; Coleoptera, 1 scolytid. In addition was much fine unidentified material and a few fragments of moss.

This interesting though somewhat homely fish is well worth studying. The aquarium, however, must be screened over to prevent it from jumping out. It has the curious habit of burying itself with great rapidity in the sand or mud at the bottom of the pool or tank and frequently conceals itself in narrow spaces in or between boulders.

[2] Determined by Dr. C. Montague Cooke, Jr., malacologist at the Bishop Museum, Honolulu.

should therefore be avoided. A few pebbles or stones, of which several are not completely submerged, will prove useful, while for plants, the common *honohono, Commelina nudiflora,* is very satisfactory. A length of this plant stem curved into a shallow dish, or a quantity placed in a large aquarium, will root out at the joints and for a time grow quickly. The neat little *Pilea peploides* Hook. & Arn. (*Urticaceae*)*, found dipping its roots from rocks in mountain streams, is a plant worth trying. Green algae such as the abundant *Cladophora* while perhaps rather untidy in effect, are useful aerators and also furnish retreats and in some cases food, for smaller water insects. Such algae may be restricted to one side of the container, the other remaining as more open water.

Semi-aquatic insects should be treated as such—they are likely to drown in steep-sided containers with water only. Plenty of debris, algae, dead leaves and a little soil may be required. Do not allow oily films to gather on the water. Aquaria should be covered with a fine screen or netting rather than with glass. Plenty of good air is often essential.

What insects get along together and what ones do not, will form an instructive experience for the beginner in the study of water-loving organisms. Many species will prove highly carnivorous and must therefore be isolated. In studying life-histories—moult-skin counts, food habits, etc.—the subject had best be placed in as small a container as is consistent with its well being, a petrie dish often serving this purpose. Thus exuviae will not be lost nor will the insect be able to conceal itself too effectively. Microorganisms such as Protozoa and the tiny Crustacea common in sunlit stagnant waters will give many young aquatic carnivorous larvae a start in life so that increasing in size, these insects will soon be large enough to feed upon bloodworms (*Chironomus hawaiiensis*) that may be found in reservoirs, leak pools, ditches, etc. The eggs of *Chironomus* are attached as short, thick gelatinous strings to stones, surface weeds, debris, etc., just beneath the surface of the water. Mosquito larvae are good food for aquatics, but they are, generally speaking, rather too agile for their capture, so that some escaping their enemies, will mature and constitute a nuisance. Finally, for larger insects, such as a third-stage *Rhantus* beetle larvae and the adult beetles themselves, and the nymphs of

* Identified by E. L. Caum.

Anax dragonflies, the tadpole of the rough-skinned little *Rana rugosa* frog will serve well. Worms, sowbugs (Crustacea), etc., may also be fed them. All food remains should be removed from the container.

Certain aquatic insects like the Odonata or dragonflies are capable of prolonged fasts, but the larvae of dytiscid beetles like *Rhantus,* being almost constantly active, cannot under normal conditions long abstain from food.

Aquatic beetle larvae generally pupate in moist soil; it is essential therefore that some sort of sloping bank of mud be made accessible to the larva, and a flattish pebble placed in an advantageous position on this little bank may be an inducement for the insect to enter the soil at that point. Or, a shallow dish of water may be sunk to its rim level in wet soil contained in a wider, taller dish and connection established between the two by means of limp weeds, algae, twigs, etc. Our dragonflies and damselflies creep up a steep bank, a boulder, plant or twig, for the final transformations; hence a steeply sloping twig, bit of wood or screen, etc., should be made to project from the water for at least a foot so that the emerging insect will readily locate it and crawl up its underside.

The eggs of many aquatic and subaquatic insects have shells of considerable transparency and provide, even without dissection or the use of stains, excellent if unrefined studies in embryology, while the larval stages, particularly the earlier ones, frequently show the tracheal, or respiratory system to great advantage, with the alimentary canal, the circulatory system, and the imaginal discs (wing buds etc.) often quite clearly outlined.

PART I. ORDER COLEOPTERA (BEETLES)

There are 7 species of aquatic or semi-aquatic beetles in the Hawaiian Islands. The Dytiscidae or "diving beetles" with thread-like or bead-like antennae are represented by 3 species, of which 2 are apparently endemic. The adults swim mainly with simultaneous or rowing strokes of opposing legs. The Hydrophilidae with the antennae somewhat clubbed and the maxillary palpi relatively long, number 4 species that are aquatic. They swim less strongly than the Dytiscidae and with an alternate or running movement of the legs. There are in addition here several land-inhabiting Hydrophilidae.

FAMILY **DYTISCIDAE**

Rhantus pacificus (Boisduval).

Colymbetes pacificus Boisduval, Voyage of the Astrolabe, Col. 1, p. 50, 1835.

Rhantus pacificus, Sharp, Tr. Dublin Soc., (2) II, p. 607, 1882.

This is our largest, most active and most aquatic water beetle (Plate II, 1). It is oval in form, and ranges from about 10 to 12.5 millimeters, or half an inch long. The general shade in pinned specimens is blackish, although when in the water a brown and coppery lustre may become evident. There is a pale area on top of the head, the sides of the thorax and the antennae and legs are, more or less, light brownish, while the wing covers are flecked, particularly outwardly, with pale brown. The male is readily distinguished from the female because it only, has a widened area of sucker-like discs on the underside of the tarsi of the first and second pairs of legs (Plate II, 8).

Rhantus pacificus is common in mountain streams. Small headwater pools deeply entrenched between banks and connected one with the other, often by scarcely more than a trickle of water, are a favorite resort of this beetle. On the island of Oahu it occurs as high as 3,500 ft., i.e., in a small spring on the slopes of Mt. Kaala, Waianae Range. This is, perhaps, the most elevated permanent water on the island. We have found it also really abundant nearly a mile high in a forest on the eastern slopes of Mauna Kea, Hawaii, dwelling in the clear cool water of little creeks, or in boggy pools along the more open trails there. On the other hand, it does not scorn rain puddles close to the seashore. On December 29, 1931, one such body of water, then in extent about 5 feet long, 2½ feet wide and not more than 3 or 4 inches deep, alongside a roadway on the island of Molokai, was found to contain, in addition to numerous "bloodworms" (the larva of the midge fly *Chironomus hawaiiensis*), hordes of small nymphs of the dragonfly, *Pantala flavescens* and a number of *Rhantus* larvae, mostly well grown. It was quite evident that in this shrinking puddle the struggle for existence was waxing more and more severe, the stronger organisms devouring the weaker. The clearest of waters or the most muddy appear to serve equally well. Near Ewa, Oahu, several *Rhantus*

larvae were found thriving in storm-water pools so reddishly muddy as to render these larvae as well as other organisms quite invisible except when right at the surface.

Occasionally one sees several of these insects propelling themselves in graceful curves near the surface of the water, with oar-like strokes of the stout, hair-fringed hind legs, exploring the bottom or resting, in seeming content at the surface, the posterior extremity of the body exposed to the air, the swimming legs curved jauntily upwards. Or, if the beetle is in a wary mood it shoots up from the depths of the pool, touches the surface for the fraction of a second and then darts down to shelter, a clinging air-silvered bubble marking its descent. A heavy footfall, or a stone cast into the water, and the beetle may vanish into the depth, reappearing in good time, for a moment, to replenish its air supply.

When taken out of water it runs rather quickly and finally flies away. It is also able to take wing from the vertical sides of a glass vessel, up which it has climbed with the aid of the surface tension of water.

With but trifling care it can be kept for a long while in captivity; one female specimen captured as an adult and fed at irregular, and sometimes rather long-spaced intervals, survived a little over eight months. In its native state it probably feeds on whatever suitable little invertebrates fall into the water, and it also devours aquatic forms. It has been observed consuming *Philoscia angusticauda* Budde-Lund, a common sowbug that is found near water and in other damp situations, and an examination of the crop contents of one of these beetles from a pool in Kamokuiki Valley, Waianae Mts., Oahu, disclosed remains, including entire legs and an antenna, of an amphipod crustacean, probably a species of *Orchestia*. Perkins (Fauna Hawaiiensis, Introduction, p. clxxviii, 1913) records it as feeding upon young nymphs of *Agrion oceanicum* McLachl., one of our larger damselflies (Odonata). It is often found in pools containing other species of damselflies. A bather on the Island of Kauai complained of having been bitten by these insects when he immersed himself in a cool mountain pool.

I was accustomed to feed some *Rhantus* beetles, confined in an aquarium, with disabled cockroaches, grasshoppers, and I even gave them a crippled centipede, and it soon became evident that they locate food more through the sense of taste or smell, than by

sight. A wounded cockroach is cast upon the water. Except for its weak struggles, there is no other movement in the aquarium. Presently, however, one of the beetles, in need of air, rises from the bottom; it catches the diffused taint of the bleeding insect and swims about near the surface. It may thus pass within an inch of the cockroach but apparently does not see it, and some moments elapse before its prey is located, into the wounded portion of which it now bites hungrily. In the meantime, other *Rhantus* bestir themselves; they swim about in an enquiring manner, and at last all are struggling to get a firm hold upon the cockroach.

As long as small fish and shrimps have plenty of space, as was the case in the aquarium, they will most likely long evade the beetles; in cramped quarters, however, *Rhantus* may successfully attack top minnows (*Gambusia*). Once a large flatworm (*Bipalium kewense* Mos.) was placed in a pool containing these beetles. Twice, one of these beetles made as if to seize and bite this slimy creature, but in the end rejected it as an unsavory morsel. Earthworms however often fall into steep pools and are then eaten by *Rhantus*.

The first two pairs of legs are fitted for grasping, though they may also take some part in locomotion. By their aid the prey is held and, if the beetle—more buoyant than water—has not wedged itself under some stone or other object, it clings to something with these four feet in order to remain under water.

The eggs of *Rhantus* are whitish, delicate and rather elongate, with the end from which the larva hatches, more broadly rounded. They measure nearly two millimeters in length. In pools, they were found glued singly to the stems and the hair-like rootlets of the moisture-loving plant *honohono* (*Commelina nudiflora* Linn.) (Plate II, 2), to filamentous green algae, to dead and partly rolled up floating leaves and to other objects immersed in water.[1] In the laboratory the eggs were also fastened to the sides of a glass dish. Few appear to be deposited at one time; a captive beetle laid 13 eggs within a week, and most of these within 2 or 3 days. As the

[1] In Guatemala the writer found that dytiscid beetles oviposited in the frothy egg-masses of an amphibian, presumably a tree toad. These egg masses adhered to objects in rain puddles, or along the margin of the latter. In this manner the beetle larva is assured an abundance of food that will enable it to complete its transformations in a fair proportion of these often very temporary puddles. Some of these beetle larvae were sent to the Bureau of Entomology, United States Department of Agriculture, and there determined as belonging to two species, of which one was a *Rhantus* The larvae readily devoured the young tadpoles.

eggs develop, the blackish eyes of the enclosed larva appear through the diaphanous shell, and a dark streak along its sides marks the position of the longitudinal air tubes. In about 3½ days the curved larva ruptures the shell. It now straightens out and is a good deal longer than the egg shell, the head is dark and well armored, and each segment of the body above bears a dark plate, of which however, the tailmost one forms a complete ring; just beyond this ring, on the upper side, are situated the paired air-tube openings for breathing, and immediately below these openings, the two slender processes or cerci arise. The underside of the larva then, with the exception of the head and terminal ring-like segment, is rather soft, and pale, and so also, when this active and voracious creature is well filled out with eating, are the spaces between the plates.

Though never attaining the speed of the adult beetle in the water, it is nevertheless a capable swimmer and, with quick oar-like strokes of its three pairs of hair-fringed legs, aided by occasionally flexing the body, travels gracefully and rather swiftly through the water. When quite young the larvae seem to favor the surface

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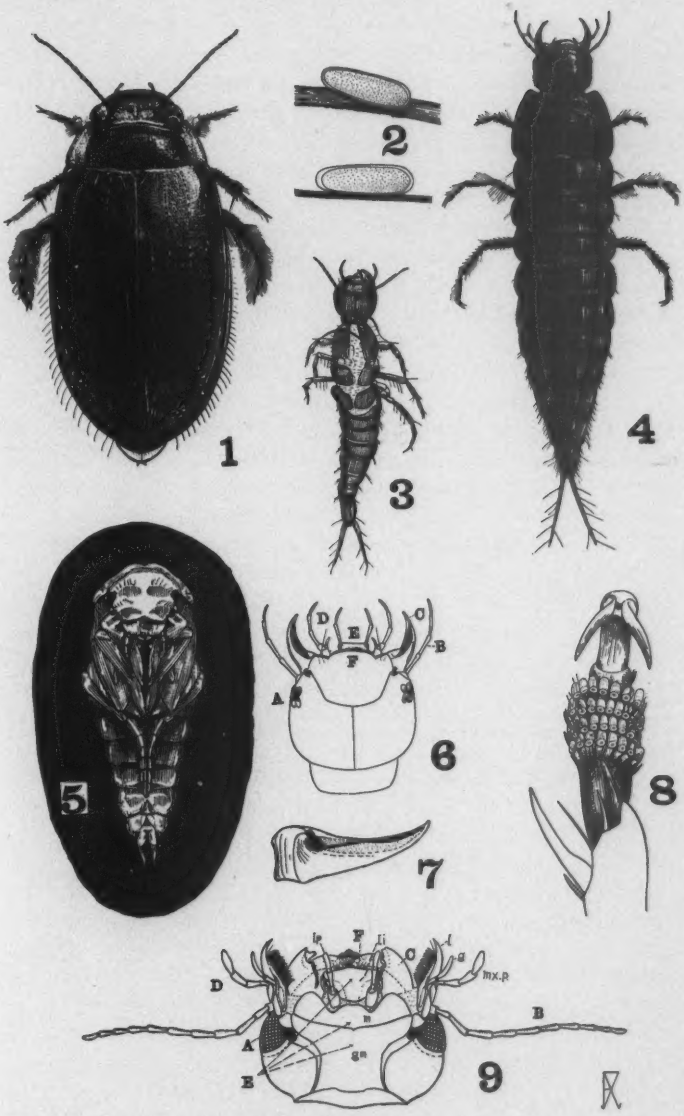
II

RHANTUS PACIFICUS

Explanation of Plate

1. Adult beetle, female. Length 11 millimeters.
2. Eggs glued to immersed plant rootlets. Length about 1.85 mm.
3. Moult skin of young larva.
4. Full grown larva. Length about 14 mm.
5. Pupa, from underside. Length about 9 mm.
6. Head of last-stage larva, from above: A, eyes; B, antenna; C. mandible; D, maxilla (= base and inner small 2-jointed appendage) and 4-jointed maxillary palp; E. labium and labial palpi.
7. Mandible detached; to show canal on inner side, black indicating its opening to the exterior, stippled shading the canal itself.
8. Fore tarsus of adult male, to show the numerous sucker discs, from beneath.
9. Head of adult beetle, female, from beneath: A, compound eye; B, antennae; C, mandible; D, maxilla (l, innner with comb = lacinia; g, intermediate palpiform = galea; mx.p, outer = maxillary palpus); E. labium (m, mentum; li, ligula; gm, gulamentum; lp, labial palpus); F, labrum. The labrum with the inner epipharynx is on the upper side of the mouth or buccal cavity; the labium is on the lower side.



Rhantus pacificus

region of the water, but the larger and more vigorous ones dive easily to the bottom of pools of some depth and explore the sides and the weeds for prey. In getting air into the air tubes which open at the base of the paired tail-like processes, the *Rhantus* larva rising to the surface, floats obliquely head downwards, jaws agape and the legs hanging freely—all lending to the appearance of relaxation. It is somewhat lighter than water, for it has capacious air reservoirs formed by the enlarging of the longitudinal air tubes. A small experiment with one of these larvae, well grown, showed that it was capable of enduring (though with obviously increasing discomfort) a submergence of at least three hours.

The mouth-parts and the method of feeding of the larvae of certain types of Dytiscidae—to which family *Rhantus* belongs—have been studied by a number of observers. The mandibles of the *Rhantus* larva (Plate II, 6C, and 7) are rather slender and curved, in strong contrast to the stout toothed jaws of the adult beetle (Plate II, 9C) and, in addition, they are deeply channelled on their inner side (Fig. 7), the channel opening rather widely near the tip and the base of the mandible and is nearly closed, slit-like, by the approximation of the two margins, in between. This is the structure in all the larval stages. In feeding, the beetle larva holds its prey in closed jaws, presumably injects a digestive fluid into its body, and then sucks out the juices.[2] When the jaws are thus closed, or nearly so, over the perforated victim, the basal opening of each channel connects with the mouth, and thus, through the partly transparent chitin there, one may see the fluid pass at intervals with great rapidity, from the base of the jaws on either side, across to the central gullet. The food habits were observed chiefly in the laboratory, where the larvae were often fed with the aid of forceps. They greedily sucked the juices of small soft insects, such as caterpillars and mosquito wrigglers, but were not always adept at capturing the latter. A *Rhantus* larva in its last stage of growth would dispose of a half dozen large mosquito larvae of an evening. It likes to feed at ease with its tail-end at the surface. When it has sufficiently sucked out the juices of its victim, the more or less chewed and shrunken remains are let fall. Except sometimes to a

[2] My few dissections of adult and larval *Rhantus* have shown that, in keeping with the nature of their respective mouthparts, the adult beetle often swallows relatively large portions of its prey, while the larva ingests only the body fluids or quite minute, more or less solid particles. Furthermore, the larva lacks the conspicous, heavily chitinized gizzard of the adult, showing that it has little need for a straining and crushing apparatus.

slight extent, it does not employ its legs in holding its prey in position, its strong curved jaws amply sufficing.

In a pool behind the peak of Tantalus (Puu Lehua) a small *Rhantus* larva was observed eating a mosquito wriggler, of which there were many in this little body of water. In the same locality on March 13, 1932, and more than a week after heavy rains, a quantity of an amphipod crustacean, *Orchestia* sp., an arched leaping creature with a compressed body and very common under wet leaves and other debris, were found dead, decaying and discolored orange red, at the bottom of a pool where two small *Rhantus* larvae were each attacking a corpse. On several occasions large *Rhantus* larvae were seen devouring *Philoscia angusticauda* (Isopoda), an abundant sowbug crustacean that frequents the margins of pools and often drowns in them. Cannibalism was noted among *Rhantus* larvae in their natural haunts and this trait is emphasized in captivity.

The larva sheds its skin twice during its active life, and thus there are three *larval* stages. The first of these moults takes place about two days after hatching from the egg. The skin splits along the pale line of least resistance in the middle of the thorax, and along the top and sides of the head, and it is cast off in its entirety (Plate II, 3), so that this discarded garment really looks a good deal like a limp larva. Immediately after the moult, the *Rhantus* larva is pale, glassy and whitish, the eyes dark, the mandibles red at their tips, the gut in part colored, and the longitudinal breathing tubes are each marked off in a broad dark stripe. But the larva soon darkens into a sort of brownish gray, and resumes its voracious activity. It moults again about three days later, when it is 8 millimeters or more in length. The color may again be a sort of sandy brown, or the head and plates may be almost black. It eats actively for a few days, and attains a length of perhaps 15 millimeters (Plate II, 4) and assumes a more or less yellowish tinge beneath. Now it refuses food, often swims about restlessly, and finally crawls up the muddy bank of its prison seeking a hole or cranny, and at last burrows under a pebble, or simply, into the mud, to a depth perhaps of less than an inch and, with the aid of its head, forms a neat, smooth, short-oval chamber. In this chamber it rests on its back, in a curved position and, in a few days the skin splits and discloses a delicate, creamy, yellowish-white pupa

(Plate II, 5) with glass-like appendages, dark eyes, a pair of slender spines at the tip of the body, and fine erect stiff, reddish brown hair, chiefly on the back, that raise it clear of the floor of the shining, damp pupal chamber. It is very sensitive and wiggles actively if disturbed. In a few days more the beetle sheds the pupal envelop. At first it is pale and delicate; so it does not dig its way out of the cell to seek water until it is strong, hardened, and dark colored.

But a single *Rhantus* was reared from egg to adult stage, as follows:

Egg laid about August 6.
Egg hatched about August 10.
First larval moult August 12 or 13.
Second larval moult August 15.
Entered soil to pupate August 28.
Adult disclosed September 4.
Or, about 4 weeks from egg to adult.

In nature, particularly in the highlands, the cycle is probably longer, but at least up to an altitude of about 1,500 feet, there seems to be no, or hardly any resting period from development, for adults and larvae may be seen throughout the year there. In the lowlands, this beetle occurs in some of the rain or storm puddles often passing through a generation or two in them.

This beetle appears to be found only in the Hawaiian Islands. It belongs to a genus of world-wide distribution that is represented by dozens of species. Among these species in other Pacific islands, are *Rhantus liopteroides* Zimmermann, *Rhantus pulverosus* Stephen, and *Rhantus annectens* Sharp, all from Samoa, and *Rhantus debilis* Sharp from Tahiti.

Copelatus (Liopterus) parvulus (Boisduval).

Colymbetes parvulus Boisduval, Voyage of the Astrolabe, Col. I, p. 50, 1835.

Copelatus parvulus, Sharp, Tr. Dublin Soc. (2), II, p. 568, 1880-1882.

Copelatus mauiensis Blackburn, Tr. Dublin Soc. (2), III, p. 120, 1884.

Liopterus parvulus, Zimmermann, Coleopterorum Catalogus (W. Junk), Pt. 71, p. 145, 1920.

This little reddish brown to blackish beetle of slender parallel form and usually between 4 and 5 millimeters in length (Plate III, 10) inhabits small, generally clear pools sheltered in the gullies of the fore-hills and ranges thence to waters in the cool uplands at an altitude of 2,000 feet, or more. It is frequently found in company with *Rhantus,* its large sturdy relative, and with *Limnoxenus,* the squeaking hydrophylid beetle. And often it dwells in tiny water pockets of an intermittent character, of which some dry up entirely while others, situated in cooler regions of considerable rainfall, may shelter beneath moist pebbles in waterless basins lined with rather hard mud, *Copelatus* beetles that await the next flood to resume activities.

Under water this restless insect reflects a rich coppery brown color, as it swims about gracefully, as a rule, hugging sides and bottom—which makes it rather difficult to capture—and occasionally rising to thrust out the tip of its abdomen for air. Both adult and larva may be taken on submerged stones when these are suddenly lifted out of water.

Of carnivorous habit, the adult beetle will readily feed upon dead insects and in the field was once found devouring a larva of its own species. Dissection of the foregut (crop and gizzard) of 9 adult *Copelatus* secured from one pool in the headwaters of Pauoa Stream, back of Honolulu, late on the morning of May 14, 1933, revealed that much, if not most of its food supply consists of the tiny copepod Crustacea that abound in the beetle's habitat and that swim in swift jerks or dart in a similar manner along the surface of submerged stones or debris. Of these 9 foreguts examined, 3 contained remains identified as those of Copepoda, 1 the remains of a small fly larva as well as unidentifiable material, 2 had undetermined insect remains, while the last three were practically empty. None of these guts contained much food, so it is clear that in order to survive the beetle must be an active forager. Food materials that had passed beyond the well chitinized gizzard were in small, unrecognizable particles. Tiny floating bits of sweet chocolate when floated on a highland pool, proved quite attractive to the beetle and to certain dolichopodid flies. The male *Copelatus* beetle has but 6 discs on the underside of the fore and intermediate tarsi (Plate III, 13)—compare this condition with the more than 30 discs in the male *Rhantus* beetle.

Several eggs were laid by captive females. They were whitish, rather stout, slightly oval and about 0.8 millimeters long. They were fastened lengthwise along the muddy bottom of the vial of water in which the beetles were confined. (Plate III, 12A) illustrates an egg in a sort of envelope to which adhere fine particles of debris, Fig. 12B shows an egg lacking this envelope. None of the eggs hatched.

After some speculation regarding the larval habits of this beetle and a considerable search, the pale straw brown larva was discovered. Whereas the larva of *Rhantus,* its large relative, is an accomplished swimmer, sooner or later to be discovered in the pool as it forages about freely or boldly rises to the surface for a supply of air, the *Copelatus* larva (Plate III, 11) has relatively secretive habits. Although of much the same graceful form as the *Rhantus* larva, its legs are unfitted for swimming since they lack the fringe of fine hairs present in the larva of *Rhantus. Copelatus* therefore, creeps about on partly submerged stones, leaves, immersed tufts of rootlets or other objects, being able then to easily take in air at its tail end and also to seek its prey which, judging from dissections of a few larval foreguts, consists of the minute copepod Crustacea that are so abundant on submerged objects or swimming freely. Of 6 *Copelatus* larvae secured from small pools behind the Peak of Tantalus (Puu Lehua) in April 1933, the foreguts of 3, or possibly of 4, showed remains of Copepoda, while a 5th one contained a single valve or shell of a small ostracod crustacean. None of this material had passed beyond the gizzard, which consists of one large and two small spiniferous pieces of chitin, the

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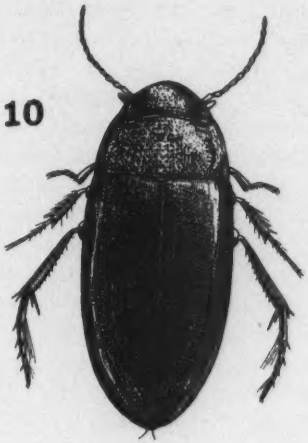
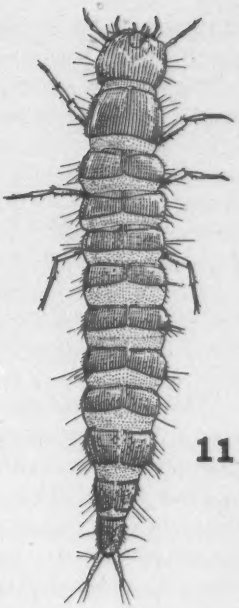
III

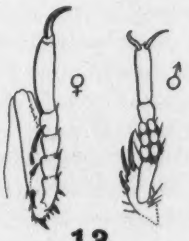
COPELATUS PARVULUS

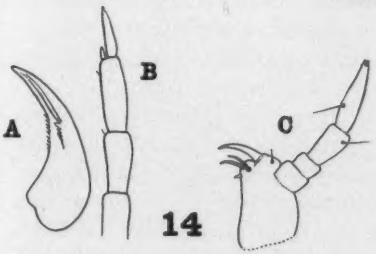
Explanation of Plate

10. Adult beetle, length 4.8 mm.
11. Larva, last stage, length 6.75 mm.
12. A, egg with envelope, length 0.8 mm.; B, egg without envelope.
13. Foretarsus of adult beetle, female without, male with sucker discs. Tarsus of female a little inclined from underside, of male directly from underside.
14. A. larval mandible, from above; B, larval antenna; C. larval maxilla and palpus.
15. Pupa, length 4.3 mm.









Copelatus parvulus

large piece being of subconic form. Since the *Copelatus* larva ingests food in a solid state, sometimes swallowing almost or quite entire, its small crustacean prey, a chitinized gizzard is to be expected. In the possession of this rather well developed organ it differs from the larva of our two other dytiscid beetles that suck the juices of their prey or at most, swallow only minute particles of more or less solid matter. In further keeping with its feeding habits, the mandibles of *Copelatus* are not deeply channeled out but have sharp bladelike edges and rows of fine teeth (Plate III, 14, A), while the maxillae (Plate III, 14, C) are rather stout and bear several strong spines on their inner side. Aside from the few dissections of alimentary tracts, the feeding habits of the larva were not studied.

This insect was not reared from egg to adult, but field collections of larvae indicate that there are three larval stages; the larva quite pale at first becoming somewhat darker at each stage and moulting for the third time to form a pupa. Although unable to swim, the larva can run about actively and may remain entirely submerged without any apparent inconvenience for an hour or more. As in other aquatic insects, colonies of the long-stemmed protozoan, *Vorticella* may sometimes be found attached to its body. A larva that was apparently full grown (Plate III, 11) measured nearly 7 millimeters in length of body. Its dorsal plates were roughened with fine tubercles that, towards the posterior end of the body were developed into short spines. This larva having been once disturbed from the little mud bank of its prison, again dug into the mud and, employing its head as a sort of ram, formed a smooth-walled subspherical cell that for a time was open above but which was finally closed by pushing mud in place with its head. In due time the very sensitive resting larva transformed into an equally sensitive pupa between 4 and 5 millimeters long, of a glassy creamy white color except for the dark eyes, and with erect hairs on the sides and back (Plate III, 15). The pupal stage is brief.

This beetle occurs in the adult state the year around. Thus far it has been reported from only the Hawaiian Islands, having been taken on Kauai, Oahu, Maui, Molokai and Lanai. It belongs to a genus of nearly 200 species, as listed by A. Zimmermann, in Coleopterorum Catalogus, Pars I, 1920, and of which 27 species are placed in the subgenus *Liopterus* of Aubé (1836).

Of interesting habitat is *Copelatus pandanorum* Scott of the Seychelles, and of which its discoverer and describer says in part (Trans. Linn. Soc. London, ser. 2, Zool. Vol. XV, pt. 2, Sept. 1912, p. 259): "The habitat of this species is very remarkable. The series before me consists of 17 males and 20 females, all of which without exception were found living in the water that collects between the bases of the leaves of certain precinctive species of screw-pine (*Pandanus*), many feet above the ground. They were found only in the endemic high damp mountain forests, in situations where the water between the leaves would never under ordinary circumstances dry up. In one case two larvae, having a quite characteristic Dytiscid facies, were also found between the leaves, showing that in all probability the whole life-cycle takes place in this curious habitat."

In the water and humus between the leaf bases of a bromeliaceous plant in the mountains of Trinidad, British West Indies, Scott discovered *Aglymbus bromeliarum* Scott, a water beetle allied to *Copelatus,* and says that "The *Aglymbus* is more flattened dorso-ventrally than its congeners, this being perhaps an adaptation for living in the narrow spaces between the leaf-bases (*Copelatus pandanorum* is also flattened)." (Ann. and Mag. Nat. Hist., Ser. 8, vol. X, 1912, pp. 424-438, 1 pl.)

Hydrovatus confertus Sharp.

H*ydrovatus confertus* Sharp, D. On Aquatic Carnivorous Coleoptera, p. 329, 1880-1882.

In certain weedy lowland swamps, in abandoned rice fields, in hoof prints of cattle and in other small water pockets by taro patches, particularly where fish have not yet penetrated, and Protozoa, rotifers, minute Crustacea and other diminutive organisms abound, an obese little water beetle (Plate IV, 16) some 2.5 millimeters long and of a variegated brown color may frequently be found.[3] Its often restless behavior suggests impatience as it swims for a short distance along the bottom, pauses a moment, and is off again. Occasionally it rises to the surface where, assuming an almost vertical position takes in a supply of air at the tip of its

[3] It may also occur in the shelter of filamentous green algae in taro patches that contain fish; and while mainly a lowland insect it dwells, with two larger water beetles, *Rhantus* and *Limnoxenus,* in certain tiny stagnant pools in boggy Palolo crater situated at about 1,400 ft. elevation in the mountains behind Honolulu.

pointed abdomen, and then usually descends immediately. Appearing scarcely larger than some of the tiny bivalve crustaceans that share its environment, this chubby little insect swims at a steady pace, not in lunges, as do some of the larger dytiscid beetles. In captivity we usually see it half running, half swimming—with pauses—up and down the sides of the glass jar, and we take note that the well-fringed first and second pairs of legs, but chiefly the second pair function most in propulsion, the slender third pair trailing behind or partaking in lesser movements, although actively operating when the beetle is swimming freely. Individuals will live for many months in an open dish half filled with water, to which some filamentous green algae, debris, and occasional food such as dead insects have been added, and the fact that the dish remains uncovered seems not generally to tempt them to fly away. The beetle does not appear to be very aggressively carnivorous; large mosquito wrigglers that share little water pockets with it seemed unmolested. Dissection of the crop and gizzard of a few of these beetles revealed some food remains capable of identification and some that was quite unrecognizable. Two of the beetle crops contained what appeared to be head-portions of the larva of a moth fly (Psychodidae); a third held fragments suggesting a tiny crustacean, while a fourth disclosed the curious bristles, or chaetae of a nereid, a worm sometimes occurring in fresh-water marshes close to the sea, but with the great majority of species characteristic of salt water. In the crop of a *Hydrovatus* beetle a few days in cap-

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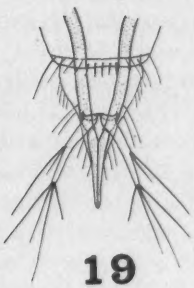
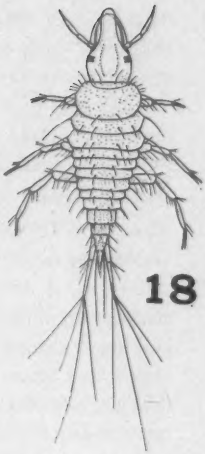
IV

HYDROVATUS CONFERTUS (16-23)
COELOSTOMA FABRICII (24)

Explanation of Plate

16. *Hydrovatus confertus*, adult beetle. Length 2.55 mm.
17. Egg. Length 0.6 mm.
18. Young larva. Length—nose to tip of middle tail process—1.33 mm.
19. Large larva. Tail to show the two entering tracheae.
20. Large larva. Head, from beneath.
21. Adult. Crop, gizzard and part of gastric coeca. To show a copepod crustacean in the crop. Laboratory-fed beetle.
22. Adult male. Fore tarsus, from side to show two of the pads of the basal joint.
23. Large larva. Head, from the side.
24. *Coelostoma fabricii*, adult beetle. Length 6 mm.





Hydrovatus confertus and **Coelostoma fabricii**

tivity was found a copepod crustacean that had been swallowed practically entire (Plate IV, 21, C). Such tiny darting Copepoda may be very abundant where the beetle lives. In its rummaging about for food it appears that the sense of taste or smell plays a much greater part than that of vision.

The egg of *Hydrovatus* is slightly curved oval and about 0.6 mm. long (Plate IV, 17). One was found weakly glued to algae in the jar-aquarium. It hatches into a very curious, rather spindle-shaped larva (Plate IV, 18) with a snout-like process against which the tips of the mandibles meet (Plate IV, 20 and 23). Looked at under the microscope this nosey little organism might well remind one of a dolphin (Cetacea), with its prominent strongly-toothed beak. For all its diminutive size it is a savage-looking creature as it runs lightly over the flocculent bottom or clings to a bit of plant near the surface, the long sickle-like mandibles agape beneath the great toothed snout-like process. Though traveling easily and gracefully under water it is unable to swim and so must creep to the surface for air, which it takes in at the sharp tail-like process into which the two longitudinal tracheae extend (Fig. 19). It may of its own accord stay under water for half an hour. In captivity the larva was fed on soft crushed insects, and living Ostracoda and Copepoda. When a quantity of *Cipridopsis* (Ostracoda), curious swimming little clam-like creatures, was placed in the *Hydrovatus* dish some of the beetle larvae soon caught one in their jaws; Copepoda however, with their darting speed were less frequently captured and I saw but one in the jaws of a *Hydrovatus* larva.

Probably the larva of *Hydrovatus* has three stages. Plate IV, 18, shows a very young larva 1.3 mm. long to the extremity of the two processes on each side of the tail. This is probably a first-stage larva. Compare its caudal portion with that in Plate IV, 19 (probably in the last larval stage). A large larva is a sort of pale brownish with dark specks, the alimentary tract showing darkly through. There is a group of six little eyes on each side of the head. Very small larvae may be almost transparent.

Hydrovatus confertus often inhabits the same waters as the small *Enochrus nebulosus* and the larger black *Coelostoma fabricii,* and I believe that the sturdy larvae of these two hydrophilids are frequently predacious upon its young.

This insect was first taken here by F. W. Terry who collected it in Honolulu on June 12, 1904. It has been taken also at Olaa, Hawaii, on April 19, 1920 by O. H. Swezey. It is an oriental species and belongs to a large genus. It is common on the lowlands of Oahu.

FAMILY **HYDROPHILIDAE**

Limnoxenus semicylindricus (Eschscholtz).

Hydrophilus semicylindricus Eschscholtz, Entomologist, p. 42, 1822.

Hydrobius semicylindricus, Sharp, Trans. Entom. Soc. London, pp. 82-83, 1879.

Limnoxenus semicylindricus, Knisch, Coleopterorum Catalogus (W. Junk), Pars 79, Hydrophilidae, p. 175, 1924.

If we were to explore even the smallest of our mountain streams for aquatic insects, it is likely that, upon turning over a partly submerged stone, or in searching the underwater banks and the bottoms of pools, we would find a convex, rather long-oval, dark shining beetle, blackish, olive green or even purplish—according to light or age—some 8 or 9 millimeters or about a third of an inch long. Detached pools are to its liking, and it lives in mountain bogs and in such little bodies of water as are choked with green algae, among the mass of which its firmly attached egg-cases may be found. It even frequents dripping-wet mossy or weedy banks above water. Once in a shaded canyon on the Island of Molokai two of these beetles were found in a shallow and somewhat stagnant quart of water in a hollow atop a boulder in a dry stream bed. The highest point at which I have yet taken this beetle is at the Gunnera-plant (*ape ape*) spring on Mt. Kaala, Oahu, at about 3,600 ft. elevation. It occurs also near sea level.

Sooner or later we might hear an underwater noise, like a protesting squeak that is produced by this insect and that is audible from a distance of two or three feet.[4]

[4] The sound-producing organ has recently been studied by Dr. O. Marcu (Zoologischer Anzeiger, Nr. 3/4, Band 100, Sept. 15, pp. 80-81, 1 Fig., 1932) in *Hydrophilus* and *Hydrobius*, the latter genus being closely related to *Limnoxenus*. In *Hydrophilus* and *Hydrobius* there is a finely cross-ridged area on the edge of the second abdominal segment, and this Marcu terms the "pars stridens", while on the underside of the wing covers and near their outer edge is a field thickly beset with fine chitinous elevations, the "plektrum". Stridulation is effected by rubbing one opposed area against the other, the necessary movement being secured probably by expansion and contraction of the abdomen. In *Limnoxenus semicylindricus* these areas are apparently quite similar to the above, the abdominal area or "pars stridens" is situated on the side piece or pleurite of the third abdominal segment. It is not a very obvious apparatus.

Like other hydrophilid beetles, *Limnoxenus* swims with alternate strokes of its rather slender legs, of which the tarsi of the second and third pairs are strongly hair-fringed on one side, the fore tarsi being weakly fringed. The locomotion is somewhat wavering and quite inferior to that of the dytiscid beetle, *Rhantus* and others, and, because of the immense spreading air bubble that often silvers the underside except the head, and renders it very buoyant, the beetle may be unable to swim to the bottom but must creep downwards among algae, weeds or other submerged objects. When at rest underwater it may be readily captured with the fingers.

On account of the comparatively small size and quick movements of *Limnoxenus,* it is not easy to see just how it takes in a supply of air; the process has been well studied by observers particularly in species of the genus *Hydrous,* and it appears to be essentially the same in these, its giant relatives. When *Limnoxenus* needs a fresh air supply, it swims head up to the surface, or creeps to it up the bank or along some weed, or pushes through a mass of green algae and, usually tilting the body so as to expose on one side a cleft between head and thorax (for the head has now been somewhat extruded), thrust up the hairy club of the antenna (Plate V, 29, B) and breaks the surface film. It remains in this position for a moment or two and then descends below. When the surface film of water is broken at the aforesaid cleft, a tiny basin or depression is formed there, thus establishing air communication with the underside of the body, the fine hairy covering of which retains a sheet of air. The sides of the prothorax are downbent, the basal part of the abdomen guarded eaves-like by the wing covers, and this structure probably aids in retaining the air that may swell into a bubble. The most anterior of the spiracles (S1) are a large transverse, strongly-fringed pair, situated in the membrane on the underside immediately behind the prothoracic frame. The next spiracles (S2) also large but not hair fringed except very slightly on one side, are secreted on the side of the thorax behind the upper side of a plate known as the katepimeron 2, and sheltered also by the inflexed portion of the wing covers. The third spiracles (S3), hidden under the base of the wing covers, just behind the metanotum but belonging to the abdomen, are large, transverse and well fringed. The several pairs of smaller abdominal spiracles (S4+) following, are on the upper side of

the abdomen and overlayed by the wing covers. They also are in part hair fringed. The large, close-lipped spiracles (S1 and S3), despite their positions, are quite accessible to air that the beetle takes in at the surface of the water; S3 on the back seeming accessible to the air sheet by way of the groove between the uphinging transverse hind coxal plates, and the abdomen. Air is also retained under the wing covers. The large unguarded second pair of spiracles appear difficult of access—as far as inhalation is concerned —and are probably exhalatory in function.

The adult beetle (Plate V, 25) is a mild-mannered creature that appears to be mainly a scavenger and a vegetarian. Dissection of the alimentary tracts of several individuals revealed chiefly a quantity of finely packed, reddish-brown particles that, while probably in part nutritious, certainly suggested the fine deposits or disintegrations on the sides and bottoms of the pools they inhabited. Some fine filamentous algae were also found in the alimentary canal of one or two beetles. In a tiny clear stream on the Island of Maui, some pineapple fruit rinds attracted several of the beetles, and in an aquarium, an individual remained for a day or more feeding at the inner portion of a *Passiflora* fruit. It will also eat of bananas.

The eggs of this beetle are laid in a dirty whitish cocoon (sometimes a little flesh colored) of leathery texture (Plate V, 30) that is elaborated from glands opening at the caudal end of the body). This cocoon, which is about 6-9 millimeters in length—including the strap-like prolongation—is fastened to a water plant, stone or other object, and contains a number of oval-oblong whitish eggs (Plate V, 26) about a millimeter and a half long. Three cocoons contained 13, 14 and 14 eggs respectively. Evidently they are inserted in the cocoon through an opening near the origin of the strap and which is later closed. The period of incubation was not determined but it is longer than that of the *Rhantus* water beetle.[5]

Freshly issued from the egg-cocoon the larva has a dark head and the body quite pale but with a darker shield of good size on the

[5] An egg cocoon formed about November 2 or 3, 1932, and dissected out on November 10, contained 11 eggs near hatching, besides 2 delicate whitish squirming though helpless larvae. The longitudinal pair of tracheae or breathing tubes showed plainly in these larvae and gave forth short air-silvered segmental branches each terminating in a breathing pore or stoma situated at the apex of a finger-like cone that protruded from the side of the body. It appears likely that these newborn larvae and perhaps older ones too, breathe through these lateral stigmatal openings as well as by the terminal breathing cup.

pronotum and a smaller one on the meso- and metanotum, or the upper side of the thorax. It has small antennae, a slightly oblique 5-toothed clypeus, and well-developed mouth-parts (Plate V, 28). The mandibles, similar on each side, have sharp curved extremities and a cluster of three teeth at their middle length, the maxillary palpi are very large and the basal joint armed on the inside with several short stout spines. The body is rather flattish and, in large specimens particularly, with prominent transverse folds or wrinkles. The tail end of the body above, is in part modified into an air cup which connects with the spiracles of the paired longitudinal breathing tubes. This cup which is held to the surface is kept dry and can be partly closed when the insect is submerged, a small bubble then marking its position. Full grown larvae (Plate V, 27), which may be 15 millimeters long, have a dirty brown mossy appearance because of the short hair which covers a large part of the body and helps retain the mud or other fine debris.

The young larva soon raises its head to the surface and drinks in air, plainly visible as bubbles entering the alimentary canal; more grown larvae will also take in air, thus adding to their buoyancy, for if we push a larva under water so that it sinks to the bottom, unless it is able to climb to the surface it will drown. Once at the surface, however, the rather stubby *Limnoxenus* larva with the aid of terminal air-cup into which the longitudinal tracheae

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V

LIMNOXENUS SEMICYLINDRICUS

Explanation of Plate

25. Adult beetle. Length 9.5 millimeters.
26. Egg. Length 1.55 mm.
27. Full grown larva. Length about 15 mm.
28. Head of young larva, from above: A, eyes; B. antenna; C, mandible; D, maxilla (st. stipe, pgl. lobe of palpifer, mx.p. maxillary palpus); E. labium (m. mentum, pg. palpiger, li. ligula, lp. labial palpus); F, labro-clypeus.
29. Head of adult beetle, from below: A, compound eye; B, antenna; C, mandible; D, maxilla (l. lacinia, g. galea, mx.p. maxillary palpus); E. labium (sm. submentum, m. mentum, pg.l. paraglossa of ligula, lp. palpus); F, labrum.
30. Egg-cocoons attached to a weed in water. Length 6 mm.
31. Pupa, side view. Length 7 mm.

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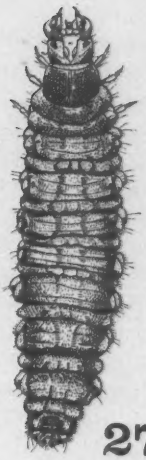
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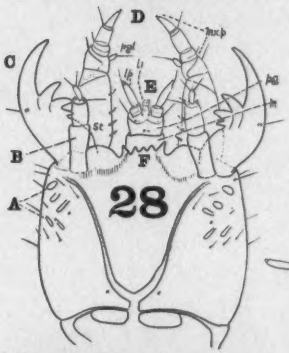

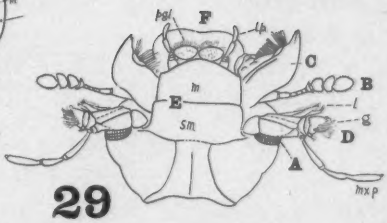

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Limnoxenus semicylindricus

lead is able to hang there in a horizontal position. It may even travel upside down at the surface of the water. Locomotion in the water is effected by a violent lashing from side to side of the body so that at the end of each stroke, head and tail seem almost in contact. For all this active movement, however, progress is quite slow. Another means of progression and perhaps the more rapid one is by turning over on the back and swimming at the surface film by regular caterpillar-like undulations of the body. Being so ineffective a swimmer then, this purely carnivorous larva prefers to await its victim than forage for it. If we were to examine the margins of quiet little pools devoid of fish, we might at last encounter there one or more of these soggy-looking larvae, the formidable jaws agape, the tail more or less exposed to air. Or, the quick disturbance of a water weed might dislodge a larva. It is also to be found on dense masses of green algae, at the water line of partly submerged stones, or even in a watery fissure in a rocky bank above water level.[6]

The food of the very young larvae was not noted afield; laboratory examples readily ate small aquatic larvae, as those of mosquitoes. In pools, one specimen was found devouring a smaller one of its own kind, while another was chewing at a psyllid bug that had fallen into the water. But, it would seem that it must sometimes endure considerable fasts. The feeding operations of the *Limnoxenus* larva are interesting even if quite a messy procedure. When it has seized a victim in its strong jaws, it may do nothing more for a while, if the prey be particularly vigorous; at last, however, it backs up, sometimes quite out of water, though itself remaining wet and, holding its prey aloft, commences chewing, passing its prey slowly back and forth across the mouth, the large-spined maxillae alternating with the mandibles in holding the victim against the strongly toothed clypeus, and working it this way and that. In this manner the victim is soon reduced to a crumpled mass that is finally cast away. The head is not invariably elevated however, when feeding.

This insect develops more slowly than the larger water beetle, *Rhantus pacificus,* but like it however, it passes through three larval instars, represented by two moults, with a third moult to trans-

[6] A quite small *Limnoxenus* larva that was progressing along the edge of a pool drew the attention of several large dolichopodid flies (*Dolichopus exsul* Aldrich), which, however, manifested no great desire to tackle this comparatively small larva, though elsewhere this fly avidly seizes the larger bloodworm larva (*Chironomus*).

form into the pupa. No specimens were carried through from egg to adult. The first two larval stages may pass quickly, but active development is withheld in the last larval stage for a period of some weeks, or even months, as far as observations on this species go. A second stage larva secured August 30, 1932, moulted into the third or last larval stage on September 4, entered the ground on about October 30, pupated on about November 9, and issued as an adult on about November 17. On February 8, 1931, an apparently fullgrown larva was found in mud under a stone in the bed of an intermittent stream at an elevation of about 2,000 feet in the Koolau Mountains, Oahu. It was kept in a small vessel with mud and water and was occasionally offered food, which, however, it accepted but infrequently. It died towards the end of June, or after a captivity of over 4 months.

This "wintering" as a large larva, has been observed in a related beetle (See Richmond, E. A., 1920).

At the end of October one of my *Limnoxenus* larvae crawled up the muddy bank of its small prison and dug a cell under a stone, and plugged up the entrance to this cell. It worked at the cell for a day or two, then cast its skin to turn into a delicate yellowish white pupa (Plate V, 31) that was provided, especially on the thoracic plate and sides and back of the abdomen with large hairs that were rather stout for their basal portion. The pupa rests upon its back, the hairs keeping its body well up from the damp floor of the pupal chamber. In about 10 days the adult beetles issued.

The beetle of course flies well.

According to Coleopterorum Catalogus, W. Junk: Pars 79, Hydrophilidae, by A. Knisch, 1924, the genus *Limnoxenus* Motschulsky, is composed of 3 species (with 3 others regarded as doubtfully valid). Of these *L. niger* Zsch. is mid-European, *M. zeylandicus* Broun, is Australasian, as are two of the species considered doubtfully valid. Our Hawaiian species then, two in number, if we consider *L. nesiticus* Sharp and which in the Catalogus is regarded as doubtfully valid,[7] are the farthest outposts in the Pacific. These two were until rather lately, placed in the genus *Hydrobius,* with its 8 or more species. In *Hydrobius* belongs the

[7] *L. nesiticus* is readily distinguished from the common *L. semicylindricus.* Dr. Perkins collected three examples of this species far up Kawailoa Gulch, Oahu, April 1893. It has a wider head, a more slight development of the mesosternal keel and deeper and coarser sculpture than *semicylindricus.*

widely distributed *H. fuscipes* (L.), the biology of which has been written by L. C. Miall in his Natural History of Aquatic Insects, 1895, and F. Balfour-Browne, in the Transactions of the Royal Society of Edinburgh, XLVII, pp. 317-340, pl. III, 1910. For an interesting work on the life-history of *H. globosus* (Say) and other hydrophilid beetles, see Richmond, E. A.; Studies on the Biology of Aquatic Hydrophilidae, Bull. Amer. Mus. Nat. Hist. XLII, Art. I, pp. 1-94, 1920. The biology of our *Limnoxenus semicylindricus* corresponds closely to that of *H. globosus,* its rather near relative.

Enochrus nebulosus (Say).[8]

Hydrophilus nebulosus Say, Exp. Long. II, p. 277, 1824.

Enochrus (*Lumetus*) *nebulosus,* Knisch, Coleopterorum Catologus (W. Junk), Pars 79, pp. 210-211, 1924.

The haunts of *Enochrus nebulosus,* the little brown hydrophilid beetle (Fig. 32), may not be attractive. We must seek it in shallow, often somewhat saline waters that are frequently choked with the succulent scrophulariaceous plant, *Herpestis monniera* H. B. K., that harbor green algae and other submerged plants and to one side perhaps, with an invading forest of rushes (*Scirpus lacustris* L.), in or near abandoned rice fields, and swamps of sweeter water where various grasses, *Scirpus,* areas of Parrot's feather (*Myriophyllum proserpinacoides* Haloragaeae), the little floating duck-

[8] Identified by Dr. E. C. Van Dyke.

VI

ENOCHRUS NEBULOSUS

Explanation of Plate

32. Adult beetle. Length 3.5 millimeters.
33. Pupa, from beneath.
34. Young larva showing air bubbles it has swallowed.
35. Full grown larva. Length about 7 mm.
36. *Lemna* plant with the egg-sac of the beetle fastened to its roots. Egg-sac without strap portion is 2.10 mm. long.
37. Eggs, well incubated. Length 0.7 mm.
38. Head of young larva, from the side, to show how the maxillae, MX, are developed to assist the mandibles, M, in mouthing food. A, antenna; L, labium.

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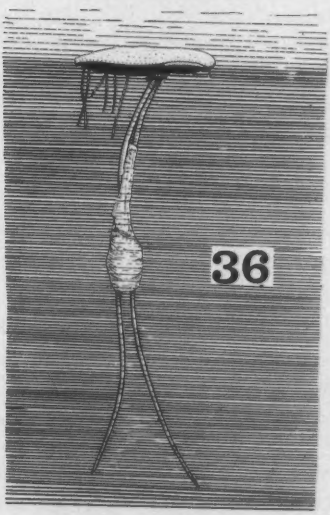

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Enochrus nebulosus

weed (*Lemna*), etc., combine in a dense growth, and finally, in the floating mats of filamentous green algae that often cover portions of our plantation reservoirs. Thus, it frequently shares its habitat with the tiny *Hydrovatus confertus* (Dytiscidae) beetle and with the very convex shining black hydrophilid beetle, *Coelostoma fabricii* (Montr.), a semiaquatic species that is an even poorer swimmer than *Enochrus*.

The *Enochrus* beetle (Plate VI, 32) is about 3.5 millimeters long, somewhat elliptical in form, not very closely knit, with short clubbed antennae, long maxillary palpi, and legs that are hardly fitted for swimming. It is, however, well suited to its environment, creeping among the plant growth and pulling itself underwater, since it is too buoyant and too feeble a swimmer to descend otherwise. Under water *Enochrus* can run nimbly along stems, etc., and it will run up to the surface, take in air at its head end and then retreat below. Frequently however, it gains the surface by simply loosing its hold, when it floats up very rapidly. Back upwards, it swims in rather a wobbly manner or, turning over so as to expose its flat air-silvered underside it runs more effectively just beneath the surface film of water. The beetle is commonly observed along the margin of shallow water. Captive specimens will crawl up the glass sides of their prison at night and take wing. In confinement they will also form and fill their dirty whitish egg-sacs, attaching them to dead leaves, the stems of plants, debris, etc. The egg-sac illustrated in Plate VI, 36, is fastened with the strap, or "mast" end up, to the roots of duckweed (*Lemna*). Altogether, it is about 5 mm. long and contains 12 eggs. Two well-incubated eggs are shown in figure 37. They measure 0.7 mm. long.

The duration of the egg stage was not ascertained for Hawaii. In New York, E. A. Richmond (1920) found that eggs of this species laid in spring hatched in 9 days. The larvae do not immediately leave the egg-sac. A freshly issued larva is a little over 2 mm. in length (Plate VI, 34). Like the rather more stoutly formed young of *Limnoxenus*, its larger Hawaiian cousin, it gulps down air that passes as silvery bubbles into the alimentary canal and thereby renders this poorly-swimming creature quite buoyant. In a partly-grown *Enochrus* larva this air gave the crop a silver lining. The insect always strives to keep its respiratory cup to the

surface; this apparatus, situated at the posterior extremity, connects with the longitudinal breathing tubes or tracheae.

Little attention was paid to the feeding habits, moulting, etc. The larva is carnivorous and must find ample food in the small organisms, Crustacea, tiny worms, fly larvae, etc., that often swarm in its environment. The *Enochrus* larva is quite active, creeping about caterpillar-like along the muddy margin of the shallows and among weeds in the water. It is probable that it seldom ventures in open water for, not being thoroughly aquatic it is a poor swimmer. It can, however, make a little progress in the water by lashing the body from side to side, or, to better advantage, though still quite slowly, by turning on its back and undulating along. When thus venter up, one notes the six pairs of low prolegs, or false feet, on the abdomen.

The *Enochrus* larva most probably has two moults, and a third moult to disclose the pupal stage. A full grown larva (Plate VI, 35) is about 7 mm. long, with a pale brown head, a good prothoracic shield, a smaller mesothoracic, and a fragmentary metathoracic one. The body is paler than the head, and divided by many transverse folds or wrinkles. It much resembles a small *Limnoxenus* larva, but is more slender and cleaner looking. The longitudinal air tubes are clearly visible from head to tail and a tracheal branch on either side goes to the spiracle at the side of the mesothorax. It assumes much the same posture as *Limnoxenus,* the head being inclined up a little while the tail end reaches up for air. Its maxillae are well developed and are employed in conjunction with the mandibles (Plate VI, 38) in manipulating its prey. The pupa (Plate VI, 33) is glassy creamy white with the eyes dark. It is stout and arched and furnished with long hairs from thickened bases and they serve to keep the pupa clear of the moist cell bottom. Larvae reared in captivity pupated in the inner concave, much decayed surface of a portion of *kukui* (*Aleurites*) nut rind that with mud and other debris formed an island afloat in a large jar of water. The pupal stage is very brief.

Enochrus nebulosus has been collected thus far only from the Island of Oahu of the Hawaiian group, and where it was first collected in 1914 by O. H. Swezey. It is a widely distributed species and belongs to a huge genus.

The subfamily Sphaeridinae of the family Hydrophilidae is represented here by several widely distributed species. They are small jet black insects of very convex form that for the most part live among manure, vegetable refuse, or in very stagnant weedy waters. Their thickish larvae are predacious, feeding largely upon the young of insects they are able to overcome. Several species were introduced here from the Orient to combat the sugar cane weevil borer but did not become established. Of the genus *Dactylosternum* we have *D. abdominale* (Fab.) and *D. subquadratum* (Fairm.). The first of these is nearly cosmopolitan while *D. subquadratum* described from Tahiti is fairly common in Hawaii and is recorded also from Samoa, Fiji, Buru, Borneo and the Philippines. Both of these beetles have the wing cases finely marked with nearly parallel dotted lines or elytral striae. *D. subquadratum* usually inhabits refuse, has been taken rarely under wet pebbles by water or at the edge of a tiny pool in the hills behind Honolulu.

Coelostoma fabricii (Montr.) (Ann. Soc. Ent. France (3) VIII, 1860, pp. 245-246) described from New Caledonia and of which *C. extrancum* Sharp of Oahu, Hawaiian Islands, is regarded as a synonym, occurs also in Australia. It is shining black, about 6.5 mm. long and its whole upper surface is dotted with tiny close-set punctures (Plate IV, 24). It is common in the lowlands of Oahu and occurs also on Molokai and probably elsewhere in the Archipelago. It is often found in company with the smaller, relatively more elongate brown *Enochrus nebulosus* and is quite at home in muddy shallows and in foul brackish water choked with vegetable growth and odorous of sulphur. Although a poor swimmer indeed, it can turn very deftly on its back and run along thus with its air-silvered underside just below the surface film of water. It often descends under water by creeping down some partly submerged plant or other object. The adult beetle is probably chiefly a feeder in vegetable matter and several individuals that I placed with a piece of papaya soon penetrated this soft fruit and could be seen moving their jaws within it. The leaves of Asiatic pennywort (*Hydrocotyle asiatica* Linn.) were also eaten by *Coelostoma* beetles. Captive specimens formed lens-shaped egg cases with a wide thin margin and somewhat suggesting the egg case of a spider. They were dirty whitish, rather tough, about 4.75 mm. in

the diameter of the double convex portion and were fastened flat to a bit of floating wood. One case was opened and found to contain 11 eggs arranged in 3 tiers enclosed in a rather fine fibrous sheathing material. The young larvae are of stout form and, as in *Limnoxenus* and *Enochrus,* imbibe air.

The dentition is alike or with quite minute variation in both mandibles.

PART II. ORDER ODONATA (DRAGONFLIES AND DAMSELFLIES)

Professor C. H. Kennedy (The Origin of the Hawaiian Odonata Fauna and its Evolution within the Islands, Proc. of IV Intern. Congress of Entomology, Ithaca, Aug. 1928, 1929, on pp. 978-979) writes as follows: "The Odonata fauna consists of about forty forms in thirty distinct species, the other ten being geographical races. Five species are Anisoptera. The remainder are a closely interrelated group of Zygoptera, all belonging to the supergenus *Megalagrion,* named so for the very large size of some of the species. This genus is so closely related to the oriental genus *Pseudagrion* that the more generalized species of *Megalagrion* could be placed in *Pseudagrion* without hesitation, if found in the Orient."

The Anisoptera or dragonflies are characterized as adults in having a relatively stout body, with wings held horizontally when at rest, the hind wings being broader at the base than the forewings, and the young variously known as nymphs, naiads or larvae, in having the "gills" within the stout spine-tipped abdomen, and in the squirt method of swimming. The Zygoptera or damselflies are of more slender form with the fore and hind wings of practically the same shape and size and usually held together or slightly apart over the back when at rest, and with the nymphs with three more or less flattened gill plates at the end of the abdomen, and swimming by a wriggling or sculling motion.

Two of the dragonflies and all of the damselflies are found nowhere else in the world, and thus the Hawaiian Odonata fauna is 90% endemic.

SUBORDER ANISOPTERA (DRAGONFLIES)

FAMILY **AESCHNIDAE**

Anax strenuus Hagen.

Anax strenuus Hagen, Verh. Ges. Wien, 1867, p, 34 (♀); Blackburn, Ann. Nat. Hist., (5) XIV, 1884, p. 413 (♂).

It is only here and there among our native insects that we find really large species. The giant Hawaiian dragonfly, *Anax strenuus* (Plate VII, 39) is one such. Not only is it the largest dragonfly in the Territory, but it surpasses in expanse of wing, if not in bulk as well, *Anax walsinghami* McLachlan, the largest dragonfly in North America.[9] The wing expanse of *strenuus* is usually at least 5 inches (127 millimeters); those measuring 132 millimeters are common, while the largest specimen that has yet come to my notice is in the Bishop Museum, Honolulu, and spans 143 millimeters. A specimen reared by the author measures 142 mm., or 5⅝ inches. A pair of these giants hovering close at hand tandemwise over the water appears hugely out of proportion with the rest of the insect population. As these insects rather leisurely pass beyond us along some little mountain stream, the male can be readily distinguished from the female by the conspicuous blue area just behind his thorax. And when one pauses nearby in its exploratory flight we see the immense eyes alive with light, the spiny legs folded against the breast, and hear the gentle rustling of rapidly moving wings. Sometimes one may be seen dipping its abdomen in the water, or more rarely perhaps, dashing itself again and again flat upon its surface, fluttering there a moment, and then easily arising from it. When hovering low over a pool, the water beneath it trembles from the draft caused by its fanning wings. Capable of great speed it will dart up or down some watered canyon or

[9] Needham and Heywood, 1929, p. 130. Expands 122 mm. Seeman, Theresa M., 1927, p. 24: "Expanse of wing 114 to 126 millimeters". "The largest species, the most gigantesque of recent Odonata, is *T.* (*Tetracanthagyna*) *plagiata* Waterhouse, recorded from Borneo, Sumatra and the Malay Peninsula. The female may have a span of over 170 mm." [up to about 7 inches]. Laidlaw, F. F., The Dragonflies (Odonata) of Burma and lower Siam—III, Subfamily Aeschninae, Proc. U. S. Nat. Mus., *62*, Art. 21, 1923, on page 18. This expanse of wing however, may be exceeded by the very slender damselfly (Zygoptera) *Megaloprepus coerulatus* Drury, from Central America and the females of which sometimes measure 190 mm. across expanded wings.

course high in air about a mountain top.[10] It is a familiar insect of the upland roads of many sugar cane plantations, but may also be found in certain localities at sea level. Quick to perceive its prey, the larger damselflies are among the victims of its rapacity.

While the two species of Anax (*A. strenuus* and *A. junius*) may be distinguished by structural characters (Plate VII, 40 and 41), tandems consisting of the male of one attached to the female of the other have been observed by Perkins (Fauna Hawaiiensis, Introduction). Apart also from the difference in size and structure, the costal or front margin or vein of the forewings of *strenuus* is mainly quite dark, whereas it is pale in *junius*.

During late November, 1933, while studying aquatic insects in the mountains of East Molokai, a few notes were made on the egg-laying of this dragonfly. The locality was at an elevation of about 2,100 ft., where the clear Moaula stream, wedged in a canyon luxuriant with vegetation, flows seawards, quickening its pace to lower levels by a succession of waterfalls that culminate in the lofty Halawa Falls nearly two miles away. The fauna of at least the upper portion of this stream appears rather scant. The curious Hawaiian goby or *oopu,* so abundant at lower levels seems uncommon at 2,100 ft. The fresh water shrimp (*Atya*) on the other hand, is numerous here. Both fish and shrimp, then, are able to surmount large waterfalls.[11] There are some aquatic snails, several species of damselflies, as well as certain chironomid flies (*Tanytarsus* and *Telmatogeton*) found also in these upper waters. Noteworthy though rather solitary in habit is the fine, almost ma-

[10] Although dragonflies number among the swiftest of flying insects, their powers of flight are due to the superbly balanced proportions of wings and body rather than to any great muscular power, which indeed is considerably exceeded by many insects. Hold for example, a thick-bodied moth, butterfly or a skipper butterfly by the wings brought together over the back and compare their muscular exertions with that of a large dragonfly held in a similar manner.

[11] The ventral fins of the goby are united into a sucker-like disc by the aid of which it is evidently able to climb up very steep places. A note on the climbing ability of the shrimp is as follows:

In July 1932, while in the upper sugar cane lands of Onomea Sugar Company on windward Hawaii, the writer observed young *Atya bisulcata* shrimps between a half inch and one inch in length, travelling up a V-shaped wooden flume 1/3 full of water estimated to be running at about 15 miles per hour. By means of a loose plug or dam of weeds the flow of flume water had been diverted over the side whence it made its rapid way, almost as a cataract, to a natural stream in a canyon several hundreds of feet below. This was the source of the shrimps that somehow climbed up, and then through the weeds and debris at the overflow of the flume, somewhat raised from the ground; they conquered the overlapping boards in the flume section and made their way presumably, to headwaters. I saw 20 or more of these crustaceans working their way up against the flume current. They were in the edges of the flow; just completely under water or awash so as to form a ridge there. One could see their antennae. In progressing, they walked from one to several inches and then paused. They could see well enough and leaped full in the water when I attempted to capture them.

jestic, brilliant green *Liancalus metallicus* Grim, that giant among Hawaiian dolichopodid flies. Perched warily head upwards upon a moist boulder, often in midstream, at the plunge of, or alongside a cataract, this big fellow demands cautious stalking and a swift and accurate swing of the net for its capture.

At this 2,100 ft. level then, about a small area of quieter water in the Moaula stream, I chanced upon two tandems of *Anax strenuus* searching for a place to oviposit. The males of one or both of these tandems were rather quarrelsome, for, encumbered though they were with mates, one would attempt to drive away the other. Soon getting down to business however, the tandems again flew about rather slowly, searching the rocks and debris in the water, and one pair choosing an old, water-soaked piece of *ieie* vine (*Freycinetia*) stem, alighted on it. Now the rear insect or female of the tandem, inserted her abdomen part way under water along the stem and drawing back the stout curved ovipositor situated near the extremity of the abdomen and that when not in use fits into it much like the blade in a clasp-knife, she forced it into this stem and with a saw-like motion cut a slit. This operation was repeated again and again, the thorn-like ovipositor securing a new purchase after every slit. The actual insertion of the eggs was not observed, but an examination of this *ieie* stem revealed a number of *Anax* eggs each in a slit cut at a slight angle from the surface. Some of these eggs were so shallowly imbedded as to be exposed

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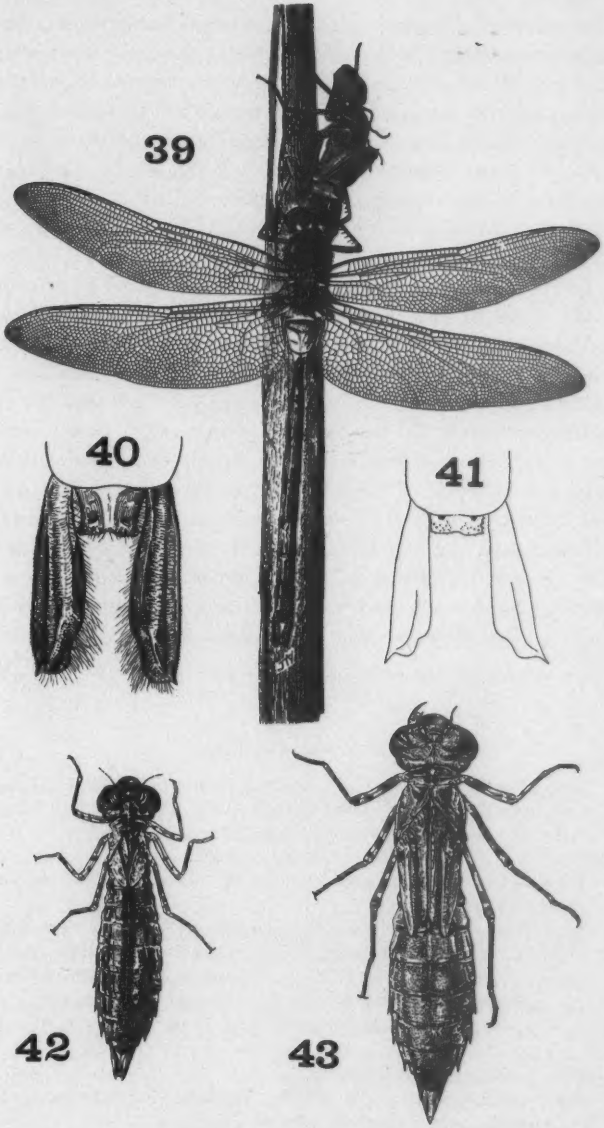
VII

Explanation of Plate

39. *Anax strenuus,* the giant Hawaiian dragonfly a few hours after emergence from the nymph, to the empty skin of which it partly clings. This is a male that has a wing expanse of 137 millimeters, or 5 3/8 inches. From a photograph by W. Twigg-Smith.
40. *Anax strenuus,* male, showing superior (paired) and inferior anal appendages. From above.
41. *Anax junius,* male showing (in outline) the superior and anal appendages. From above.
42. *Anax junius,* nymph about three-quarters grown. Length 35 mm. From a photograph by W. Twigg-Smith.
43. *Anax strenuus,* nymph, a day and a half before producing the adult. Note that the wing pads and the thorax are swollen and the antennae and mouth parts are no longer functional. Length 54 mm. Waianae Mts., Oahu. From a photograph by W. Twigg-Smith.



Anax strenuus and **junius**

at the surface for a good part of their length; in any case, the end that bore the horny cap was more or less exposed or even protruding. Eggs of *Anax strenuus* are commonly inserted in submerged portions of the often semi-aquatic *honohono* (*Commelina nudiflora*) and no doubt at times are intermingled with those of *Anax junius*, its lesser relative of generally lower levels, the range of these two insects overlapping however. Likewise, a *Commelina* stem may in addition to the eggs of *Anax* bear many eggs of damselflies (*Megalagrion*).

The eggs of *A. strenuus* (Plate VIII, 44-47) are perhaps more usually arranged in a double row that may be slightly oblique to the length of the plant stem into which they are inserted. They lie head outwards and upwards and may be from a little less, to a little more than 2 mm. long, or as much as 2.25 including the somewhat darker cap at the head end. The egg of *A. junius* is somewhat smaller. The incubation period was not positively determined; but on the mainland of the United States it has been found to be about three weeks for *A. junius*. The insect issues from the egg as the "pronymph" or first larval stage. It then resembles somewhat a tiny pupa enveloped as it is in a tight chitinous membrane and with the legs glued to the body. This stage is of exceedingly brief duration (3 to 20 seconds in *Anax*, according to Tillyard, 1917),

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VIII

Explanation of Plate

44. *Anax strenuus*, egg imbedded in stem of *Commelina nudiflora*. Enlarged.
45. *Anax strenuus*, egg from side; cap at upper end. Length about 2 mm.
46. *Anax strenuus*, pronymphal skin extruded from shell.
47. *Anax strenuus*, egg shell with emergence slit.
48. *Anax strenuus*, nymphal stage immediately following pronymph. Length about 2.6 mm.
49. *Anax strenuus*, nymphal stage following figure 48; showing respiratory system, the branchial basket lying chiefly in the yellow abdominal band. Within the dark abdominal band and just behind the pale thorax, and commencing between the converging air tubes or tracheae are the oval-shaped remains of the yolk in the midgut. Length about 3 mm.
50. *Anax junius*, egg well incubated.
51. *Anax junius*, young nymph, showing incipient wing buds between base of posterior legs. Length 12 mm.
52. *Anax strenuus*, egg, parasitized by an *Anagrus* wasp, at W.

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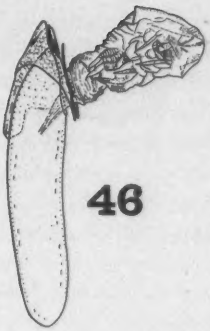
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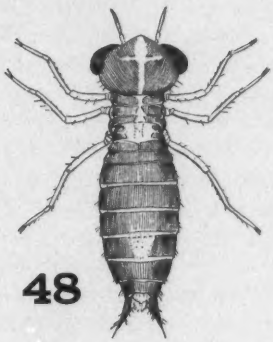
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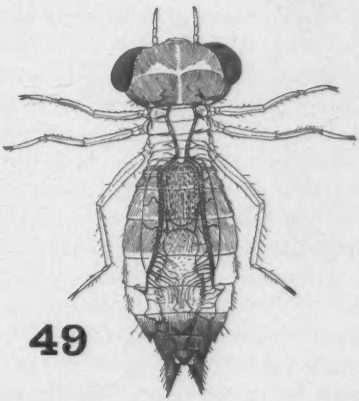
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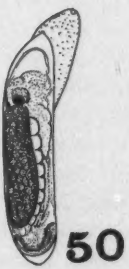
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Anax strenuus and **junius**

and during these few seconds it moves very little, since it may not entirely free iself from the egg slit (Plate VIII, 46). When the first moult, producing the second stage larva or nymph occurs we have a diminutive though active insect, the dark brown shade of which is varied chiefly by a pale canary yellow cross on top of the head; this yellow is continued along the dorsum of the thorax, beyond which it finally diffuses a good deal and further along the abdomen is represented by rather obscure pale bands (Plate VIII, 48). When we see one of these tiny larvae swimming rather tediously in open water—wriggling the body, moving the legs, and expelling water from its tail end—we realize that it has reached a stage in its existence that is fraught with peril. The little pool in which these midgets were observed navigating contained also voracious *Rhantus* larvae and probably the adult beetles as well. But locomotion in the young *Anax* nymph soon improves and it becomes more addicted to clinging quietly to some submerged stone, root or twig, and to darting out at some small moving organism, or perhaps stalking it with no little skill. With more growth it is able to swim in a swift darting manner by vigorously expelling water from the hind end of the alimentary canal wherein the respiratory organs are situated. Pale yellowish markings persist with some changes through several moults, disappearing however, well before the larva is half grown, when it is mainly brownish or slightly dark olive greenish, variegated somewhat by paler and darker markings. The legs are pale banded. The *Anax* larva sheds its skin a number of times, soon acquiring little wing pads that increase in size with each moult, the compound eyes also growing larger and nearer together. Directly after each moult it is very pallid and greenish except for the dark eyes, and tips of the mandibles and maxillae. It is then comparatively helpless and so rests quietly until the integument darkens, becomes tough and the insect is again strong and active. Finally, it reaches a length of two inches or more. The large dragonfly larva is a dark and sinister inhabitant of the deeper pools of mountain streams, and is not immediately to be discerned as it rests in immovable expectancy, one might say, of a meal, among the somber boulders, submerged twigs, or on the bottom itself. Sometimes this keen-sighted insect ventures towards the shore, and my approach to a pool would occasionally be a signal for both tadpole and *Anax* to scoot to shel-

ter. By reason of the reflection upon the pool, its ledge-like banks and the large boulders that help shape it, the wary larva is often difficult to capture; an appeal to its appetite, however, in the form of an earthworm dangling from a string into the depth, will sometimes lure it within reach of a cautiously wielded net. It feeds upon damselfly larvae, smaller examples of its own kind, larvae of chironomid flies, occasionally the larvae of the *Hydrobius* water-beetle, drowning earwigs and undoubtedly upon many other insects that fall into the water. Unidentified remains of a small crustacean have been found in its alimentary canal, as well as the long-conical shells of the common aquatic snail *Melania,* and those of the stouter and smaller ones (*Physa* or *Lymnaea*). The smaller shells may be swallowed entirely but larger ones are broken up in its jaws with quite an audible gritty crunch. Aquatic mites (acari) fall a prey to the smaller larvae. And no doubt, the tadpole of *Rana rugosa* Schlegel, the little Japanese frog so abundant in some of our streams, is on the bill of fare of *Anax.* Large dragonfly larvae are well known as enemies of small fish but in turn serve as food for larger ones. Upon spying a prospective victim this big dragonfly becomes the picture of stealth, and so very gradually at last, may it approach the object of its desire that it usually succeeds in capturing it by means of the hinged mandibulate labium or lower lip, which is shot out with great rapidity.[12] Frequenting the same pools as *Anax strenuus* is the little native shrimp (*Atya bisulcata* [Randall]) of our mountain streams. This vigorous and hard-shelled crustacean is often very numerous but I do not think that at least in its later stages, it suffers much from the attacks of this dragonfly nymph. In close quarters however, where attempt after attempt can be made, *Anax* may be finally successful. Dr. Edmondson in his paper on Hawaiian Atyidae (Bernice P. Bishop Museum, Bulletin 66, 1929) on page 31, writes: "Dragonfly nymphs are common inhabitants of mountain streams. A very large one attacked and almost instantly killed an adult shrimp when the two were released in a small container". Two large *Anax strenuus* nymphs that I confined with *Atya* shrimps, did, after a num-

[12] Here, however, we must often except the common top minnow *Gambusia affinis* (Baird and Girard), a very alert and active little fish. When a number of *Gambusia* were placed in aquaria each containing a large nymph of *Anax strenuus,* one or two of the fish—perhaps dazed or injured—were very soon captured and devoured. But as soon as the other fish got their bearings, they anticipated, as it were, the moves of their stealthy foe and usually evaded capture.

ber of unsuccessful attempts, succeed each in grasping a crustacean by the tail and despite vigorous struggles, consumed them.

While *Anax strenuus* seems to favor clear stream waters, it may be successfully reared in an ordinary well aerated aquarium of moderate or even small dimensions. Though naturally a wary creature, it will learn to seize living food offered it with a pair of forceps. Thus I have fed one with medium large cockroaches and grasshoppers, and also flies skewered on the end of a piece of broom wisp. If the prey be large and vigorous it is held off a little in the extensile labium (Plate IX, 57), somewhat as one would a sandwich, to be leisurely bitten into. It is very particular, however, that the struggling prey does not lay strong hold of its own body. A long-horned grasshopper, *Conocephalus saltator* (Sauss.), a capable insect with its jaws, was once incorrectly seized, with the result that it firmly grasped its would-be captor by the fore part and evidently gave it a good bite; the *Anax* larva immediately resorting to its usual mode of defense, writhed and, bending forward the abdomen, dislodged the orthopter by a jab or twist of its spiny tail, and then dashed off. For a while at least, thereafter it was more cautious about seizing its prey. An *Anax* larva devouring a soft slippery tadpole is not a particularly pleasing sight. The

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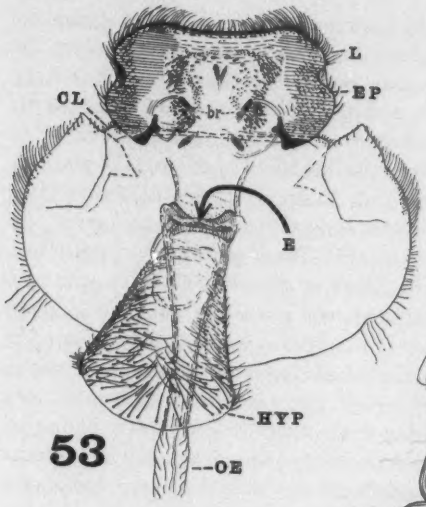
IX

ANAX STRENUUS

Explanation of Plate

53. Adult. Lower front portion of head, to show labrum or upper lip L (underside); EP, epipharynx, with its hair brushes (taste organs ?) br; CL, lower corner of clypeus; HPY, hypopharynx—a sort of tongue—bent back (down) to show at point of curved arrow E, the entrance to the throat or oesophagus OE. Inside view.
54. Adult. Maxilla: C, cardo; ST, stipe; P, palpus; IL, inner lobe; a, a, a, movable teeth.
55. Adult. Right mandible. MM, muscles.
56. Adult. Labium; SM, submentum; M, mentum; sq, squama; ml, median lobe; ll, lateral lobe; mh, movable hook; eh, end hook.
57. Full grown larva. Head from beneath, with "mask" or labium unfolded back and the right maxilla removed; L, labrum; EP, epipharynx; MD, mandible; MX, maxilla; HYP, hypopharynx; E, eye; SM, submentum; M, mentum; ml, median lobe; ll, lateral lobe; mh, movable hook; eh, end hook; t, tendons.



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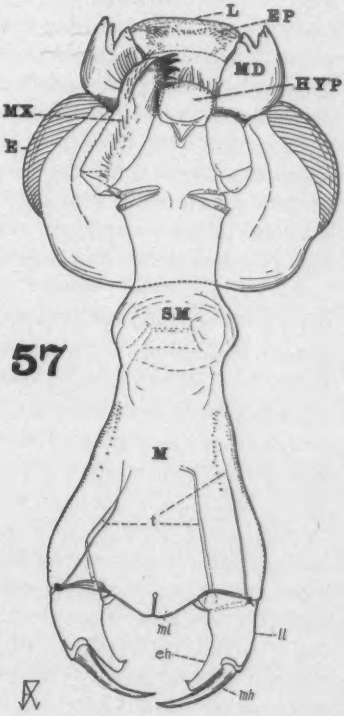

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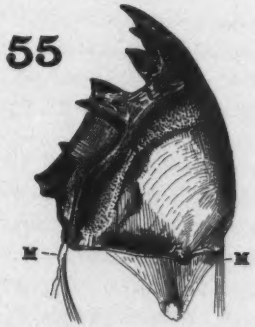

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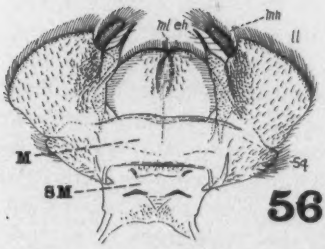

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Anax strenuus

larva holds its hard-breathing victim in a bulldog grip against its sudden and violent struggles and very deliberately consumes the unfortunate creature. A small geckonid lizard offered to a large *Anax* larva was quickly seized, but the integument of the reptile proved too tough and so, after some chewing, was abandoned.

From a few eggs found imbedded in *honohono* (*Commelina*) stems growing partly in the little Kukuiala stream, Waianae Mts., Oahu, on September 16, 1933, several *Anax strenuus* larvae had hatched by the end of that month. These were kept together in a good-sized aquarium having sand on the bottom, some stones, a few lengths of *Commelina* stems and a mass of filamentous green algae at one side. The larvae of the *Tanytarsus* midge, damselfly larvae and other insects furnished food for these *Anax,* which however commenced preying on one another so that soon very few were left, and at last but one remained. This one, usually well supplied with food increased rapidly in size and finally attaining a length of 54 millimeters produced an adult dragonfly during the dark of the morning of February 10, 1934. Thus, for the full development from the laying of the egg to the hatching of the adult *Anax* about 5 months were required. This is a brief period of development when compared with that of *Anax junius* on the mainland where a real winter retards growth so that nearly a year elapses before the insect has passed through all its stages.

At 5:20 p.m. of January 5, the *Anax strenuus* larva above referred to moulted into its last larval stage. It measured 46 millimeters in length prior to this moult, when it was clinging subvertically head upwards to a stone. Through the integument of the dorsum of the thorax a white spot representing part of old tracheal or breathing tube lining became apparent. It is about this region that the integument splits right down the middle, separating also at the back of the head and along the inner margin of each eye. A pale green swelling now bursts through the thoracic fissure while anteriorly, a large new head, also greenish save for the dark eyes and tip of mandibles and maxillae, is emerging from the cracked head shell. Meanwhile, the "mask" or jointed labium with which prey is captured, extends backwards towards the breast. As the new-skinned larva, its head bent somewhat breastwards, almost imperceptibly works itself out of the dark integument, by expanding and contracting the abdomen it seems, the appendages are suc-

cessively freed—the wing pads, the mask, and then the legs—these are all immobile and extended backwards. The abdomen gradually slips from its old casing until only its apical fourth or so remains within. The mask at first slowly, and then rather quickly, folds up loosely under head and breast and finally, the legs, which have moved very little, now reach forth, grasp the old shell, or exuviae, and quickly pull the abdomen entirely free. Up to this point some 12 minutes have elapsed. The soft larva now is almost entirely pale green, giving it a rather unsubstantial and almost ghostly appearance. Some brownish is visible in the abdomen. Forty-five minutes after the commencement of the moult the color of the larva is apparently unchanged, but at 8:10 p. m. it has darkened and some brownish markings are evident on the back and sides. The color, a sort of olive green, becomes darker and darker. I fed it again. By January 14 it has grown considerably, measuring 54 millimeters in length and is of a dark olive green color with some dull brown. It becomes browner and browner, that color being quite evident on the wing cases and a broad dorsal thoracic area. By January 21, the thorax appears to be somewhat swollen. More and more does the thorax swell and the wing covers, now pale brown, have also thickened (Plate VII, 43). Later on, it takes no food,[13] becomes rather inactive and, finally abandoning the rapid squirt method of progress, turns head up and breathes air at the surface by one or both of the large thoracic spiracles (mesostigmata). In the darkness of the early morning of February 10, it climbs up a stick, and well out of water, moults for the last time to transform into a fine large aerial dragonfly. Upon liberating a newly matured though vigorous *Anax* it ascends steadily into the air to a great height.

A second *Anax strenuus* reared from one of a number of eggs found imbedded in the leaf-sheath stem of a stray taro plant (*Colocasia antiquorum* Scott, var.) in a mountain stream on June 16, 1935, shows development and moults as per following table:

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[13] When in this state *Anax* nymphs will reside peaceably together in a small receptacle, where otherwise one would soon devour another. The writer kept together for over a week a nymph of *Anax strenuus* and of *A. junius* that in their sluggish swollen state shared the same emergence stick. The larva of the *A. strenuus* took no food for at least 10 days prior to hatching into an adult. This semiquiescent state might well be likened to the pupal period of insects with complete metamorphosis, since in both cases the tissues are being altered into those of the adult insect.

Instars:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Days duration:	a few seconds?	?	5½	7-8	5-6	4	6-7	6-7	14	5	8	21	22	37-38	38-39
Number of antennal joints:		3	4	4	4	4	5	5	5&6	7	7	7	7	7	7
Number of tarsal joints:		1	2	2	2	2	2	3	3	3	3	3	3	3	3
Wings:					Rudiments		increasing in size								
Length in mm.:		2.6					increasing in size								53

The egg hatched about June 18 or 19. The pronymphal or first instar lasts probably less than a minute. Disproportionate duration of some of the instars is probably due to a varying food supply. The last several instars are naturally quite long. In its ultimate or 15th instar this nymph's final meal was on the morning of December 7. At that time it was still a good swimmer, but the wing pads were beginning to swell and stand apart. The adult dragonfly, a male, hatched on December 21 or 22 and measured 133 mm. or 5¼ inches across outspread wings.

Several of these insects were noted at various steps in adult development. The larvae or nymphs always left the water under cover of darkness, climbing up some convenient object; in captivity a twig or leaf, in nature usually the underhanging side of a large boulder by, or in the stream. A light seemed to disturb them. Hanging securely from its perch, the larva undergoes some slight movements which assist no doubt in future development; in due time the integument of the swollen thorax bursts above, the integument of the head likewise, and the thorax and head of the adult insect appear through these breaks. When it has issued from the larval shell as far as the basal part of the abdomen, the developing adult is hanging curved back and head-downwards. It remains in this position for a time immovable or almost so, except for an occasional twitch. Finally, as if suddenly coming out of a trance, it bends up and forward and with now extended legs grasps the portion of the larval shell before it, and pulls itself entirely out of it and hangs freely head up. Now puffy, huge-eyed, green and purple it resembles a caricature of some sort rather than a graceful

dragonfly. But its stubby, dead white and much wrinkled wings begin to develop immediately so that in a few minutes they have attained their full length of over 2 inches each; they are a beautiful silvery transparent and still held close together over the back, extend beyond the yet rather chubby abdomen. Before very long the abdomen assumes its proper slenderness and length, the wings are suddenly brought down in the familiar horizontal position and soon *Anax,* though not as yet a vigorous insect, is able to fly well enough. Some days elapse before it has acquired its full coloration and a strong flight.

Like other insects this dragonfly has enemies. Its eggs are parasitized by an *Anagrus* wasp (Mymaridae), a tiny insect finally discernible in the *Anax* egg as a reddish form that occupies hardly half of its host (Plate VIII, 52). An adult male *Anax strenuus* taken December 1935 on the Island of Lanai by Mr. R. L. Usinger bears a number of subglobular, six-legged mites crowded on parts of the sternites or underside plates of several abdominal segments. These acari however, probably do little injury to so large an insect. The young *Anax* devour one another, and it is quite probable that frogs eat the insect during the precarious period of transforming into an adult.

The mouth parts of this dragonfly are figured on Plate IX.

Anax junius Drury.

Drury, 1773: Mtk. Cat., p. 105.

The big green darner, as this dragonfly is known on the mainland of the United States, is nearly cosmopolitan in its distribution and quite common in the Hawaiian Islands. A near relative of our giant *Anax strenuus,* it averages about an inch less in wing expanse, and differs again from that species somewhat in the form of the terminal appendages and in having the front margin of the wings pale yellowish, instead of mainly dusky as in *strenuus.* And furthermore, *junius* is rather the brighter hued insect of the two, both as a nymph in its later stages (Plate VII, 42) and as an adult. The male *junius* has the head, thorax and first segment of the abdomen green, the remainder of the abdomen being pale blue and black. The female has the greenish extending to include the second segment of the abdomen, the slender remainder being chiefly a gray brown above with green on the sides of the few terminal

segments. Specimens of this dragonfly that have a wing expanse of 114 millimeters are considered large individuals though not uncommon, while those measuring 110-112 millimeters are frequently met with, and hence it would appear that these Island representatives are of a generally greater size than the same species on the mainland where Needham and Heywood (1929) give its wing expanse as 105 mm., and Seeman (1927) as 107 mm.[14]

While *Anax junius* is often found in the same situations as the endemic *Anax strenuus,* and indeed Dr. Perkins (1913) has several times ". . . taken the male of the one attached to the female of the other . . .", it is an insect more characteristic of the lowlands, where it breeds in reservoirs, rice and taro fields, swamps, and even in brackish water. Adult dragonflies may often be seen patrolling the higher ridges behind Honolulu and they are frequent in and about the city itself, where their voracious nymphs are sometimes a hazard in goldfish ponds. Occasionally the adults are carried to great heights by air currents, Prof. W. A. Bryan recording a specimen taken from an ice water pool at the summit of Mauna Loa, which has an elevation of over 13,000 feet (Proc. Haw. Ent. Soc., III, No. 4, p. 295, 1917).

Alfred Warren in an article entitled "Dragonflies and their Food" (Proc. Haw. Ent. Soc., III, No. 2, pp. 72-82, 1915) gives considerable data of the food of the adult and nymph of *Anax junius* and of *Pantala flavescens* Fabr., the commonest dragonfly here. Adult *Anax junius,* as represented by 24 individuals, were found to have consumed a total of 45 insects (and one mite) representing six orders. The commonest victim was the honey bee, *Apis mellifica* (9 individuals),[15] while of mosquitoes, only 3 individuals were recognized. One damselfly had been eaten and also a single specimen of the dragonfly *Pantala flavescens.* The insect sometimes captures some of the more injurious moths as these are flying about cane fields.

Towards sunset of a quiet and rather warm day in April 1935, the writer observed in Honolulu a number of green darner dragon-

[14] On August 3, 1935, alongside a plantation reservoir at Waianae, Oahu, the writer placed his net over a trio of *Anax junius* struggling together on the ground. Their wing expanses were as follows: 102, 110, and 117 mm. (= 4⅝ inches).

[15] *Coryphaeschna ingens* Rambur, a somewhat larger dragonfly than *Anax junius,* is quite destructive to the honeybee in southeastern United States where it is known as the bee butcher (Needham and Heywood, 1929).

flies flying low over the beach and to some little distance out over the water. They were evidently feeding upon a species of fungus gnat so numerous at the time as to fill the air. The *Anax* flight continued until well past 6 o'clock, when they were observed flying among the tall coconut palms.

Pairs of *Anax junius* may often be seen about lowland reservoirs and weedy swamps, the female dragonfly with her abdomen part ways in the water, inserting her amber yellow eggs (Plate VIII, 50), slightly less than 2 millimeters long, in the stems of various plants in more or less submerged debris, or she may rest on a dense mat of green algae and probe it with the tip of her abdomen. When inserted in the quite slender stems of *Marsilia,* the eggs produce obvious bulges in them. Mainland observations by entomologists give the incubation period as about 3 weeks and the nymphal life as 11 months. It is certain that at least under favorable conditions here, the nymphs develop much more rapidly. Its food is usually abundant here and the water, particularly the shallows, become very warm during the day. Where our lowland bodies of water contain no fish, but teem with such minute Crustacea as Ostracoda, and with bloodworms, *Chironomus hawaiiensis,* the nymph of *Pantala flavescens* and *Megalagrion xanthomelas,* our lowland damselfly, *Anax* thrives exceedingly. In the shallows of a weed-choked pond near the sea, the writer remembers seeing the nymphs of *Anax junius* almost in hordes and in a number of different instars. And where top minnows abound, the aquatic weeds, particularly the mats of algae, afford sufficient cover for *Anax* to breed in some numbers; and when the nymphs are well grown they no doubt venture to attack the smaller fish as well as the tadpoles. A gentleman in Honolulu who kept some goldfish in a pond in his garden complained of the brazen voracity of the *Anax* nymph which would attach itself to a fish swimming by. Observations by Warren (1915) on the nymphs of *Anax junius* and *Pantala flavescens* combined, showed their food to be chiefly bloodworms (*Chironomus hawaiiensis*) and minute Crustacea (*Cypris,* Ostracoda). Mosquito larvae did not figure largely in their menu.

The nymph of *Anax junius* undergoes many moults. In its early life it is conspicuously bicolorous (Plate VIII, 51)—pale yellowish and dark brown; later it is brownish, more or less striped with green and is flecked with darker spots, etc. It is then some-

what more definitely patterned and less dusky than the nymph of *Anax strenuus,* that dwells in generally more shady situations in the uplands. The full-grown nymph of *junius* is about 45 millimeters long. The adult issues under cover of darkness.

A very readable account of the life of the big green darner is that by Needham, J. G., and Heywood, H. B. (A Handbook of the Dragonflies of North America, 1929, on pages 7-10).

FAMILY **LIBELLULIDAE**

Nesogonia blackburni (McLachlan).

Lepthemis blackburni McLachlan, Ann. Mag. Nat. Hist. (5) XII, p. 229, 1883.

Nesogonia blackburni, Kirby, Ann. Mag. Nat. Hist. (7) II, pp. 346-348, 1898.

"Hab. On all the Islands, in mountain forests, or deep valleys, . . . The species is variable in colour, size etc." Perkins, R. C. L., Fauna Hawaiiensis, II, p. 62, 1899.

Like *Anax strenuus* Hagen, our giant dragonfly, this pretty native species is geologically speaking, considered a recent arrival in the Hawaiian Archipelago. Kirby created a new genus for its reception, but Kennedy (1929, p. 979) states that: "*Nesogonia* is so close to the holarctic genus *Sympetrum* of fifty or more species that it could be put in that genus with little argument."

N. blackburni (Plate X, 60) has an expanse of wing of from somewhat less than 3 to about 3½ inches. The wings are for the

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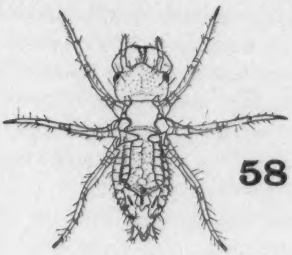
X

NESOGONIA BLACKBURNI

Explanation of Plate

58. Recently hatched nymph, with mask or labium partly extended. Tracheae or respiratory tubes and the dark midgut (containing yolk mass) showing.
59. Three-quarter grown nymph. Among its hairs are *Vorticella* (Protozoa), diatoms and sewage-like bacteria.
60. Adult dragonfly. Expanse of wing a little less than 3 inches.
61. Egg, the day before hatching.
62. Eggs, one day old. 0.54 mm. long by 0.35 mm. thick.
63-65. Rough sketches of developing adult. 63, development at 10:10 p.m.; 64, at 10:35 p.m.; 65, at 10:50 p.m.



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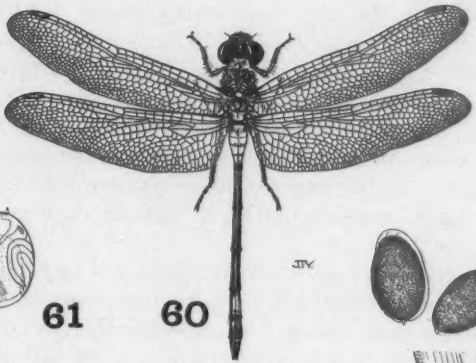

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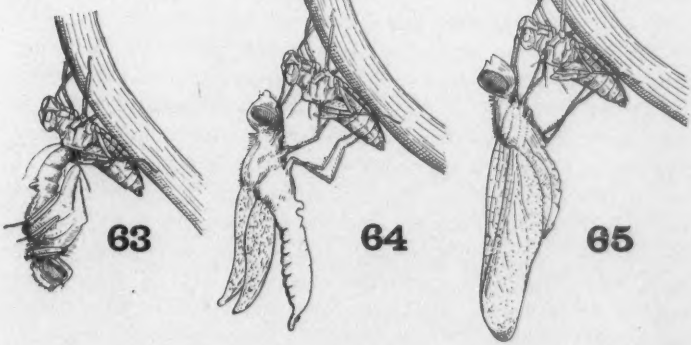


63 64 65

Nesogonia

most part nearly transparent, but the stigmal spot is reddish brown, while at their narrowed base there is a little yellowish brown and just before which, at their articulation with the thorax, there is a bit of red. The body is mainly dark, almost blackish, with some yellowish or greenish-yellow dashes on the thorax, a suffusion of reddish at the bulbous base of the abdomen and a long spot of that color towards its slightly clubbed extremity.

Sometimes we may see this dragonfly sunning itself in the middle of or alongside a mountain trail, but it is more usual to find it about small streams, where it perches with outspread though somewhat downbent wings, on boulders, or rocky stream bed, on twigs, leaves, etc., that are on or relatively close to the ground. Watching this insect near at hand, its head will perhaps be seen to move this way and that, as thus with great bulging eyes it appraises passing insects—other Odonata, with which it may quarrel, or small flies to serve it as food. If perchance *Nesogonia* be sufficiently near a swarm of the delicate green *Tanytarsus* midges hovering lazily over the water, it may dart into this swarm, seize a midge, regain its perch and there leisurely chew up the tiny insect.

The egg-laying operations of *Nesogonia* are very simple. She may select a pool in midstream, a small detached one that is becoming stagnant, a clear spring, a thin flowing sheet of water or a puddle choked with weeds. Hovering alertly she dips down and somewhat forward so that the tip of her abdomen strikes the water; she repeats this performance again and again, darts on a little way, selects another spot, hovers and again dips her abdomen in the water. One female was seen to meneuver with clattering wings among a dense growth of *Commelina* plants and occasionally to dip the extremity of the body in this stem-choked puddle. A well worn individual that seemed not to possess much energy alighted in order to lay her eggs, in this case in shallow water. If we capture one of these insects thus engaged in ovipositing and examine the club-like extremity of the abdomen, we would find on its underside a cavity or basket[16] full of pale translucent, yellow eggs, each filled with a granular material. Each of these stout eggs is about half a millimeter long and one-third of a millimeter wide (0.54 x 0.35), as measured in one example (Plate X,

[16] The bursa copulatrix.

62), and one adheres to another to form a mass. If, however, we dip the abdomen in the water, some of these eggs will separate and sink to the bottom. Thus *Nesogonia,* by dipping the extremity of her abdomen with a rather forward movement, in the water, washes the eggs out of her basket and lets gravity do the rest.

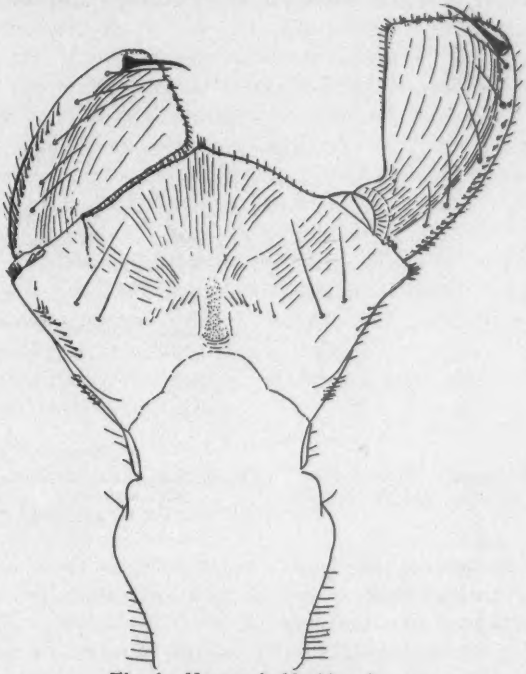


Fig. 1. *Nesogonia blackburni.*
Labium of last stage nymph,
from inside.

When in the water, a clear gelatinous envelope is seen to surround each egg. Later on, additional eggs pass into the bursa copulatrix and, in time, oviposition is repeated. The eggs turn a sort of amber yellow and develop rapidly so that in a few days a well advanced embryo with its curved appendages and large yolk mass, is discernible (Plate X, 61). In about 11 to 13 days—in the laboratory—the eggs hatch into sprawling, spider-like nymphs (Plate X, 58, after the pronymphal moult) that soon and without feed-

ing attain about twice the length of a newly laid egg and exhibit through a transparent skin a well-defined respiratory system with paired dorsal and ventral tracheal tubes, connections and branches extending far into the legs and antennae. Visible also is the rather opaque mass of yolk that occupies the mid gut and that supplies the first nourishment to the tiny nymph; all subsequent meals must be earned!

Fig. 2. *Nesogonia blackburni*; last stage nymph. Antenna.

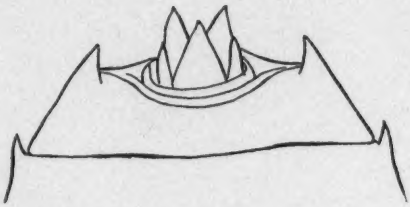


Fig. 3. *Nesogonia blackburni*; last stage nymph. Apex of abdomen.

The nymphal development was not followed through. Many young in various stages of growth were taken from time to time, and adults reared from nymphs captured late in life. It is a very sluggish creature that stays on the bottom, in masses of confervae or on the side walls of pools. It is sometimes seen in company with certain damselfly nymphs in stagnant pools containing mosquito (*Culex*) wrigglers. Particularly in its later stages, when it sheds its skin at longer intervals, it may develop a very unkempt or frowsy appearance, the nondescript brown body then harboring colonies of long-stemmed protozoans (*Vorticella*), while diatoms and clusters of sewage-like bacteria will accumulate profusely among the hairs (Plate X, 59). This shaggy covering of micro-organisms makes *Nesogonia* rather inconspicuous in the water and this would be considered by some to be of distinct advantage to it in the struggle for existence.

The nymph is easily reared, for it is a hardy insect capable of enduring long fasts. Captive specimens will often come to the surface at night and this movement probably occurs in nature as well.

The adult hatches under cover of darkness, and at least under laboratory conditions, the nymph may commence to emerge from the water late in the afternoon. It is now about 23-24 millimeters or a little less than an inch long. For several days it has taken no food and it remains quietly in the water near the surface. At the proper time it crawls up some boulder or other convenient surface, the skin parts along the head and thorax and the soft and swollen adult works through the fissure until its head, thorax and the basal part of the abdomen are free. It is now suspended head downwards, legs folded against the breast (Plate X, 63). The developing insect gives an occasional twitch and at last suddenly bends up and forward and grasping the firmly anchored nymphal shell, pulls itself completely out of this exuviae. Thereafter wings and body develop rapidly (Plate X, 64, 65), and markings appear so that by morning it is ready to essay a flight.

Adults may be seen throughout the year, and no doubt eggs are laid during this entire period.

Pantala flavescens (Fabr.).

Libellula flavescens Fabr. Ent. Syst., Suppl., p. 285, 1798.

This large brown cosmopolitan species (Text fig. 4), is the best known dragonfly on Hawaii. Fraser (Insects of Samoa, Fasc. I, 1927, on p. 41) speaks of it as the dominant dragonfly of the world, while Needham and Heywood (Dragonflies of North America, 1929, on p. 252) further attest its wide distribution when they name it the "Globe-Skimmer". While typically a lowland species, *Pantala* may frequently be seen on the wing well up in the mountains. It is a pretty sight when some dozens of these airy creatures, each shining golden bronze in the late afternoon sun, are patrolling some open space along a country roadside, or in the town itself. And when the shadows lengthen still more, these sociable insects will disband to perch for the night on a convenient vine or bush. These resting places are selected with some circumspection and several of the insects may rest quite close to one another.

The adaptability of *Pantala* to its surroundings and its relatively quick transformations account to some extent for its abun-

dance. The insect seems to lose no opportunity for laying its eggs —this being done on the wing—and the nymphs may at times fairly swarm in lowland marshes, rain puddles, rice and taro fields, as well as in reservoirs. Top minnows must keep it in considerable check where the fish abound, but dense algal growth affords the nymph a degree of protection. Likewise does this insect breed, along with other species, in rock pools left by high water of open streams such as are to be found about the Hilo coast of Hawaii. When occurring in numbers in small shallow pools the nymphs—that can see quite well—form a rather ludicrous crowd as they squirt noisily away in panicky haste at one's approach.

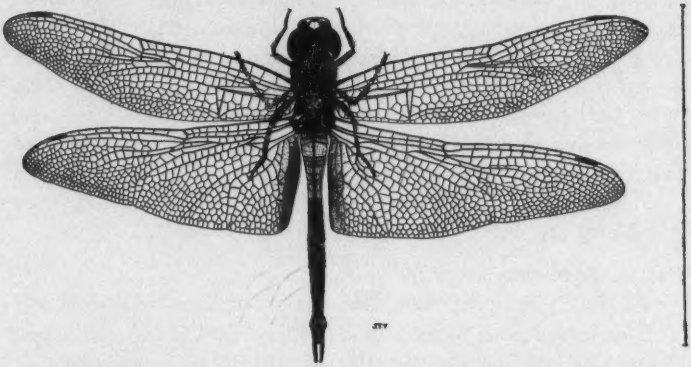


Fig. 4. *Pantala flavescens*, our most common dragonfly. (From "The Insects and Other Invertebrates of Hawaiian Sugar Cane Fields", 1931).

Alfred Warren (College of Hawaii Publications, Bulletin No. 3, Honolulu, October 1915, 45 pages; illustrated) has made an interesting study of the biology of *Pantala flavescens* and to a lesser extent, of *Anax junius*. The female *Pantala* lays a great many eggs—these being deposited freely in the water when she strikes the tip of her abdomen on the surface. Warren secured 816 eggs from a single female. The eggs are whitish at first but turn yellowish later on and measure about 0.33 x 0.20 mm. The incubation period was found to be from 5 to 7 days. Counting the pronymphal state as the first instar, Warren found that there were 11 to 12 instars (10-11 moults). According to the amount of food given them, the nymphal period varied (in 4 examples) from 55 to 101 days. The nymphs—as per dissection of the alimentary

canal of field caught specimens—fed upon a variety of animals—of which insects predominated—these being by far best represented by bloodworms (*Chironomus hawaiiensis*). The tiny clam-like crustacean *Cypris* was a good second. The adults ate many kinds of small flying insects; flies first, and then small moths predominating in an examination of the alimentary canal and mouth parts of 218 of these dragonflies.

The nymph of *Pantala* (Plate XI, 67) is of the "sprawler" type, it is broad and somewhat flattened. When full fed it is about an inch long and considerably resembles the less common *Tramea lacerata* that inhabits much the same situations. From Plate XI, it will be seen however that the *Tramea* nymph has somewhat the wider and more angular head, the abdomen too is perhaps relatively more broad and there is some difference between the two in the spines about the apex of the body. But a front view of the face of these two nymphs shows marked differences—*Pantala* has the broad lateral lobes with strong, deeply incised, saw-like teeth, while *Tramea* has low, and rather poorly defined, rounded teeth (Figs. 68 and 69).

Pantala flavescens is a notable migrant. Robert McLachlan (Ent. Mo. Mag., VII, 254, 1896) in a note quotes from the Meteorological Log of the P. and O. steamer "Victoria", Capt. Worcester, R.N.R., as follows: "April 11th 1896, 11 P.M.—'Numerous dragonflies appeared in chart room and cabin. Nearest land Keeling Island, N. 20 W., 290 miles, N. W. of Australia, S., 70 E., 900 miles.' At the time the wind was moderate from eastward with heavy rain." And F. C. Fraser (Rec. Indian Museum, XXVI, 443, 1924) writing on Odonata of W. India, says of *Pantala flavescens* as follows: "A universal dragonfly found throughout the year. In the Nilgiris, I witnessed two years running, a flight of these insects from North East to South West which lasted for several weeks during the months of September to November. This flight is probably an annual migration and is spoken of by the natives as 'the pilgrimage'."

In Hawaii this insect may fly at least until sunset, and in this connection a further quotation from Major F. C. Fraser, on dragonflies from the Andamans (Rec. Indian Museum, XXVI, 410, 1924) is of interest relative to this species. "It is not uncommon to find this insect adopting crepuscular habits, and concern-

ing the specimens in the present collection, Dr. Annandale remarks —'Flying over open grassy places when the sun has set'."

Tramea lacerata Hagen.

Hagen, 1861, p. 145.

This large, swift flying insect (Plate XI, 66) is easily recognized by the black area at the broad base of the hind wings. This black varies in extent and form with the species of *Tramea,* its jagged or torn appearance well meriting the name of "Raggedy Skimmers" given by Needham and Heywood (1929) to the members of this genus.

Tramea lacerata is well distributed over the mainland of the United States. It is widespread over the lowlands of the Hawaiian Islands but is not particularly abundant. Occasionally we see a specimen flying about Honolulu, but it is more at home over marsh and reservoir in which it passes its early stages.

The subspherical eggs are released freely in the water when the female dips forward the tip of her abdomen in it.

The full grown nymph is about an inch long (Plate XI, 70). It is marked in shades of green yellowish and brown. The compound eyes are more prominent than in its relative *Pantala* and its abdomen perhaps a little wider, while the teeth on the lateral lobes of the labium of *Tramea* are low, and rounded and thus hardly well marked. It swims well by squirting water from the end of its body and by making rapid backwards strokes with the fore and middle pairs of legs, the third pair being held back and somewhat diverging.

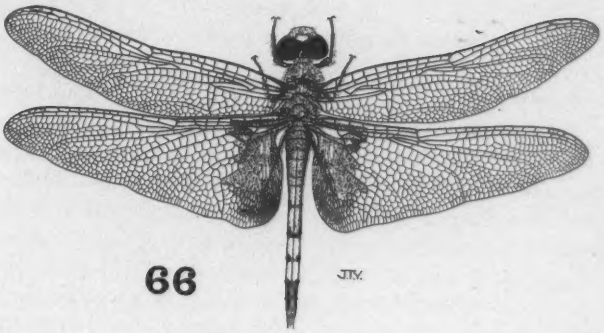
The few nymphs of this insect secured by the writer came from a reservoir at Waianae, Oahu.

XI

Explanation of Plate

66. *Tramea lacerata,* female. Wing expanse 94 mm. or 3¾ inches.
67. *Pantala flavescens,* full grown nymph. Length about 25 mm.
68. *Pantala flavescens,* front view of head of full grown nymph to show well developed teeth of lateral lobes.
69. *Tramea lacerata,* front view of head of full grown nymph to show low blunt teeth of the lateral lobes.
70. *Tramea lacerata,* full grown nymph. Length about 27 mm.

Figs. 66, 67 and 70 drawn from photographs by W. Twigg-Smith.



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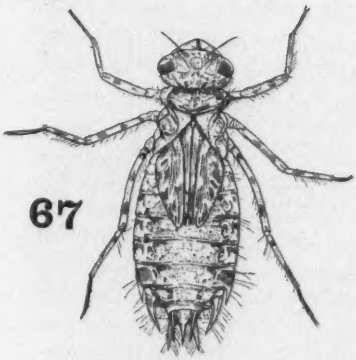

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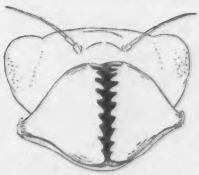

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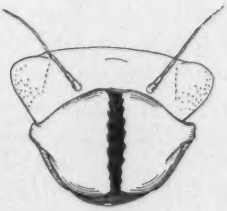

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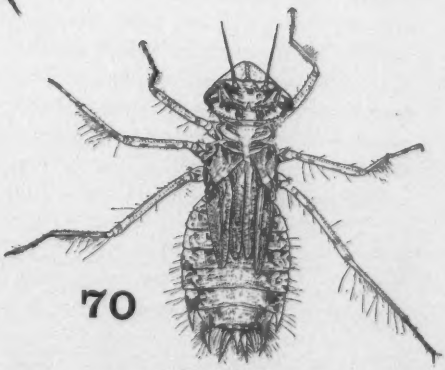

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Tramea lacerata and **Pantala flavescens**

SUBORDER ZYGOPTERA (DAMSELFLIES)

FAMILY **COENAGRIONIDAE**

The Hawaiian damselflies, some 25 species in number, belong to the supergenus *Megalagrion*[17] and are among our most interesting and attractive insects. All are peculiar to the Archipelago while more than half of them seem to be restricted to particular islands of the group. Probably derived from a single species that reached our shores at a very remote period, *Megalagrion* has undergone considerable evolution so that it is now divisible into a number of subgroups, each of which contains one or more species. These subgroups appear to be founded on characters of the adult insects[18] (McLachlan 1883, Perkins 1910, Kennedy 1920, 1922 and 1929); enough, however, is known of the early stages of Hawaiian damselflies to show that here as elsewhere among the Odonata, a classification based upon the structure and even the habits of the naiads, nymphs or larvae—as the young are variously called —is also possible.

We owe much to Dr. R. C. L. Perkins (Fauna Hawaiiensis, I, Pt. VI. pp. clxxv-clxxx, 1913; II, pp. 63-77, Pl. V, 1899; II, Pt. VI, pp. 693-696, 1910; and Proc. Hawaiian Ent. Soc., I, pp. 50-51 and 93, 1906, and II, pp. 180-181, 1912) for data on the habits, distribution and relationships of our damselflies, and the rather brief notes of Dr. Perkins on these insects indicate that his store of knowledge regarding them is very considerable. Valuable also are his unpublished notes pinned with certain of the specimens.

The adult damselfly is an insect that is almost delicately graceful, with a very slender abdomen (more slender in the male) and two pairs of long narrow wings of nearly equal length held, when not in use, close together or slightly expanded edge on, over the back (Plate XVI, 108). The wide mobile head is provided with great bulging and sometimes beautifully colored eyes (and face)

[17] *Megalagrion* has been subdivided by Kennedy (Ohio Journ. Science, XXI, No. 2, Dec. 1920, on page 86) into three genera, as follows: *Hawaiiagrion*, that includes *deceptor, calliphya, nigrohamatum, vagabundum, molokaiense, microdemas* and others; *Kilauagrion*, that includes *nesiotes*, and *dinesiotes* Kennedy (Ann. Ent. Soc. America, XXVII, pp. 343-345, 1934); and *Oahuagrion*, for the species *oahuense*. Presumably this would leave McLachlan's genus *Megalagrion*, as used in the strict sense, to include the large species *blackburni, oceanicum* and *heterogamias*.

[18] The most convenient of these characters to use are the two pairs of terminal appendages of the male (see Plate XVII) and the mesostigmal plates of the female. The mesostigmal plates, sometimes partly overlapped by the posterior portion of the pronotum are thus situated at the anterior part of the mesonotum (see text fig. 9, for *M. oahuense*).

that are quick to perceive moving objects, while the strongly spinose legs placed well forward may be used as a sort of basket to help capture insect prey and to place it within reach of the jaws. A curved and ensheathed spine-like process, really consisting of four closely-applied pieces (Plate XVIII, 119), very near the tip of the abdomen beneath, of the female, marks the ovipositor, which is finely saw-like on the inner side and thus adapted for cutting slits in plant tissues or other materials for the reception of the eggs. The male is provided with clasping organs at the end of the abdomen, while the copulatory organs are near the base of the abdomen and the genital aperture opens on the 9th segment.

A few of our damselflies may be found near sea level. The majority, however, are forest insects and occur chiefly along watercourses and high ridges, their larvae having been collected at elevations of at least 5,000 feet (Nauhi, Hawaii), while adults extend to much greater altitudes. The smaller species may not be strong flyers, but the larger and more robust kinds of the *M. blackburni* type—the males of which are often conspicuous because of their bright-red color—are quite vigorous on the wing. Damselflies are able to fly backwards. Their bill-of-fare includes many kinds of small insects. It has frequently been observed that they are fond of small moths, which are caught on the wing or when perched. Occasionally they pounce upon flies that may be walking on the ground near their perch, and they devour swarming midges, as do the damselflies on our mainland.[19] On Oahu I once observed a large female damselfly, probably *M. deceptor,* pounce upon a lacewing fly (*Chrysopidae*) that was flying by, settle with it and consume it quite or nearly in its entirety, requiring nearly 55 minutes for this meal. I saw one of the chrysopid's wings crumple up between Megalagrion's jaws. Hardly was the meal finished than it flew up at what appeared to be a sharpshooter bug (*Siphanta acuta* Walker), but finding this too hard or bulky, dropped it. Small aculeate wasps (*Nesomimesa* or *Crabro*) that hovered close before the resting damselfly were not seized by it. Not infrequently they prey upon damselflies smaller than themselves, particularly when these, as freshly emerged individuals invite capture by a weak flight from one point to another. Not all small insects form suit-

[19] Garman, P. (Bull. State Ill. Lab., Nat. Hist., XII, Art. IV, 1917, p. 445) found that adult damselflies consume a great many small Diptera, of which nematocerous flies form a large part.

able food however, for a staphylinid beetle was once seen captured in flight and then rejected as being perhaps, of too hard a texture for consumption. In eating, the broad, somewhat scoop-like lower lip or labium effectively holds the prey from beneath, while the sharp-toothed mandibles and the maxillae chew and pass it along.

In her egg-laying operations the female damselfly may be accompanied by the male, that then holds her in tandem fashion, or she may be quite unattended. She inserts her eggs usually in plant tissues, commonly leaves and stems—green or decayed—in the water, at the surface thereof, or even well above it, and finally, quite away from water. Such eggs, according to species, range in length from about 0.70 to 1.00 millimeter. They are rather tough and quite pointed at the head end, which has a cap of a deeper shade. The operations involved in oviposition often strike one as rather aimless. The damselfly then feels about her with the tip of her abdomen, her eyes apparently serving her not at all, and many a false start may be made and much groping about, before a suitable repository for the eggs is found.

The ovipositors of our Hawaiian damselflies form an interesting study, although more should be known about the egg-laying habits of these insects before drawing very definite conclusions. I have examined the paired median processes (Plate XVIII, 119, M) of a few species. These processes in *M. koelense* and *amaurodytum* race *waianaeanum,* bear relatively large and well spaced tooth ridges. These two damselflies cut slits in the rather hard tissues of the *Freycinetia* and *Astelia* leaf midribs. In *M. xanthomelas* and *leptodemas* these tooth ridges bear a good deal of resemblance to those of the two preceding species. *Xanthomelas* and *leptodemas,* as far as known, cut slits into plant tissues that are often green. The large *M. oceanicum* that oviposits in green tissues—roots and stems—and, I believe, into softer materials as well, has somewhat closer set tooth ridges than in the preceding four species, so also *deceptor* and *hawaiiense,* of which the latter commonly oviposits in soft tissues such as decayed leaf stems. Finally, in *M. oahuense* we also have rather fine and close set tooth ridges. This species was once observed ovipositing, or attempting to, in moist fern trash.

We have found that the eggs of one or more species of our *Megalagrion* that oviposit in such leaves as those of *Commelina*

and *Ipomoea*, are often heavily parasitized by a mymarid wasp, *Anagrus insularis* n. sp. described by H. L. Dozier on pages 175 and 176 of this issue.

The young of our damselflies have not been thoroughly studied and the writer's observations on them are confined chiefly to the Island of Oahu where 8 out of its 11 species were secured.[20] Some of these nymphs are widely different one from the other both in structure and in habitat. Certain species are fitted for a thoroughly aquatic life, others may spend part of their existence imperfectly immersed, as in thin sheets of water; some often wander among wet rocks and debris; there are those that live between the leaf-bases of certain monocotyledonous plants in the moist forests, and at least one species is terrestrial. In the first group are the best swimmers (as observed in *M. leptodemas, xanthomelas, nigrohamatum* and *nigrolineatum*) with a more slender form and leaf-like caudal gills that serve as efficient sculling organs; in the second and third groups are the fair to rather indifferent swimmers (*M. oceanicum, blackburni,* probably *heterogamias* of Kauai, and *hawaiiense*), much addicted to creeping, more robust and with the caudal gills shorter, broadly sword-shaped or dagger-like[21]; and finally in the last group are those that having abandoned the truly aquatic life normal to the young of Odonata, have changed over to rather squat, sometimes tenaciously-clinging, non-swimming forms with short to very short and stout caudal gills (*M. amaurodytum, asteliae, koelense* and *oahuense*). It follows that under these different environments the food of damselfly larvae may consist of organisms living in the water—and, perhaps, some that have fallen into it—of subaquatic species, or of organisms that are purely terrestrial in all stages of their existence. These and other points in the life-history of our damselflies will be brought out in the rather fragmentary observations on the several species that follow.

[20] The sex of the damselfly nymph, at least in its later stages, may be readily determined from an examination of the 9th ventral abdominal segment (Plate XIV, 93). In the male, a pair of thorn-bearing bosses represent the *valvules* of the genital pore, while in the female, three pairs of processes represent the *gonapophyses* constituting the ovipositor.

[21] The nymphs of this group bear a very considerable resemblance to the unknown coenagrionine nymph from the highlands of Hivaoa, Marquesas Islands and described and figured by Dr. James G. Needham. (Marquesan Insects II, B. P. Bishop Museum, Bull. 114, Pacific Entom. Survey, Publ. 7, 1935, on page 168). It has the wide head and general form of *Megalagrion hawaiiense* (McLachl.), while the gills somewhat resemble those of our large species of the *oceanicum* group. The entire lack of raptorial setae in the unknown coenagrionine is to some extent approached in several of our species.

Megalagrion leptodemas (Perkins).

Agrion leptodemas Perkins, Fauna Hawaiiensis, II, pp. 70-71, 1899. One male "Halemano, Oahu, about 2,000 ft.", February 1893.

This is one of our smaller and more slender species. The male has a very red face—below the antennae—part of the thorax is red and the abdomen is red except for the intermediate portion. The female is more soberly colored; the abdomen while reddish at its extremity is for the most part blackish. It is sometimes abundant back of Honolulu, where it was observed in the Hering branch of Makiki Valley, Tantalus, at an elevation of about 1,000 feet. Here is a tiny stream wedged into a steep canyon that is well shaded by great *kukui* or candlenut trees (*Aleurites moluccana* [L.]), and that harbors a generous share of our meagre aquatic fauna. In addition to *M. leptodemas,* we find here also, *M. nigrohamatum* race *nigrolineatum* (Perk.), *M. oceanicum* (McLach.) and *M. hawaiiense* (McLach.), besides our two native dragonflies, the huge *Anax strenuus* Hagen and the smaller, mountain dragonfly *Nesogonia blackburni* (McLach.). The writer found *M. leptodemas* even more plentiful in the Haleauau Stream at about 2,000-2,400 feet in the Waianae Mountains, in May 1935. It sometimes

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XII

MEGALAGRION

Explanation of Plate

71. First stage following pronymph, of *M. koelense,* or *asteliae.*

72. Egg of *M. koelense,* or *asteliae*: H, head of embryo; Y, the yolk mass. Length 1 mm. Konahuanui, Oahu, 3,000 ft.

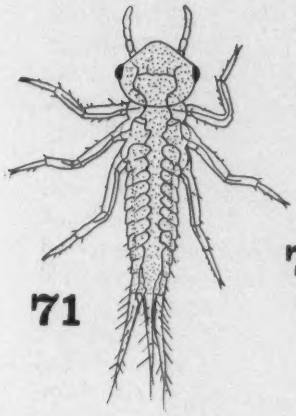
73. *M. koelense,* or *asteliae*: A, first or pronymphal stage; B, first or pronymphal moult. Rough sketch. Figs. 71-73 are drawn to same scale.

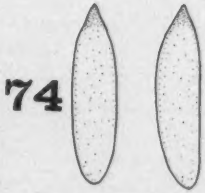
74. *Megalagrion* sp., two views of an egg of figure 77. Length 0.70 mm.

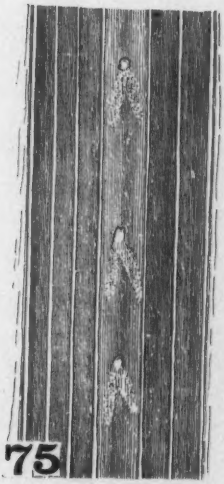
75. Basal portion of leaf of *ieie* (*Freycinetia*) to show midrib containing 3 egg punctures, each with 2 diverging eggs of *M. koelense,* or *asteliae.*

76. Very young nymph, probably of *M. xanthomelas,* from a lowland marsh. Length 1.33 mm. Probably stage following pronymph. (From Insects and Other Invertebrates of Hawaiian Sugar Cane Fields, 1931).

77. Portion of *honohono* (*Commelina nudiflora*) leaf showing imbedded eggs of *Megalagrion* sp. Hering Valley, Honolulu.







Megalagrion

occurs in the region of straggling rock puddles, at the very headwaters of streams.

At about midday of March 1, 1931, a pair of *M. leptodemas* arranged tandemwise, i.e., the male in advance of, and clasping with the end of his abdomen the fore part of the thorax of the female, was observed at one of the larger pools in Hering Valley. The female was inserting her eggs into a portion of a small leafy twig of a mountain apple or *ohia ai* (*Jambosa malaccensis* (Linn.) P.D.C.) that lay partly submerged in the pool. She spent some time apparently ovipositing near the tip of a rather green leaf, and again at the base of a small decaying bud. Her ovipositor extended just under water. The male attached to her had assumed a rigid upwards position free of any forward support. The twig portion in question was brought to the laboratory and placed in a large jar of water with some algae. On March 12, one or more eggs had hatched,[22] the nymph appearing as the usual glassy, semi-transparent little creature (as in Plate XII, 76) that we find among our damselflies in very early life before differentiation has set in. The antennae and legs are rather short and incompletely segmented while the extremity of the abdomen terminates in three spike-like

[22] It is of course possible that some eggs were laid in this twig prior to March 1.

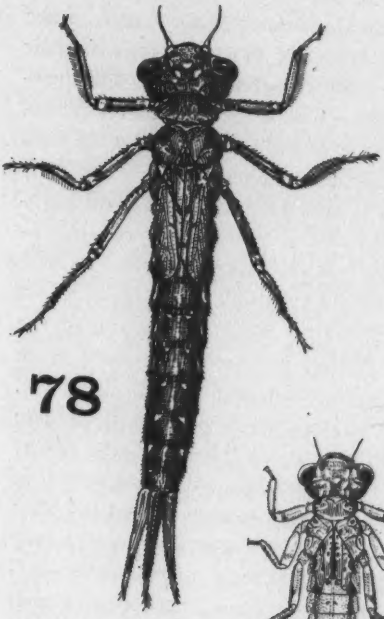
XIII

MEGALAGRION

Explanation of Plate

78. *M. oceanicum*, last stage nymph. The thorax and wings have not yet begun to swell. Length to extremity of gills 21.5 mm.
79. *M. hawaiiense*, last stage nymph near emergence. The thorax and wings have swollen. Length to extremity of gills 15.5 mm.
80. *M. koelense*, or *asteliae*, probably in penultimate nymphal stage. Found at the base of *Freycinetia* leaves. Length to extremity of gills 12.5 mm.
81. *M. leptodemas*, last stage nymph. The thorax and wings have not yet begun to swell. Length to extremity of gills 14.2 mm.
82. *M. nigrohamatum*, last stage nymph. From Molokai, 2,200 ft. It is near emergence and the thorax and wings have swollen. In this specimen the median gill is somewhat aborted and the two lateral ones are represented by dashes. Probable length to extremity of gills, about 18 mm.

Fig. 78 from a photograph by W. Twigg-Smith.



78

79

80

81

82

Megalagrion

and slightly hairy processes that are about half the length of the body. Longitudinal tracheae or breathing tubes and some of their branches show distinctly in this semi-transparent insect. This newborn though active nymph which we now see is really in the second stage, the pronymph or first stage in the Odonata being of such brief duration—a few seconds to a few minutes—that we are likely to overlook it. The pronymph is somewhat hidebound and pupa-like (Plate XII, 73, A for *M. koelense,* or *asteliae*), the appendages not being free. The young nymph soon commences to feed, snapping up tiny organisms with its extensible lower lip or mask. As it grows it moults from time to time, wings pads appear on the thorax and increase in length, the legs and antennae become more fully segmented, while the three anal gills, at first spike-like, have, moult by moult become beautiful large leaf-like structures (Plate XIV, 91), the median or uppermost of the three being the widest and all showing two axially arranged tracheal trunks pigmented in zones and giving forth delicate, more or less pigmented branches to the margin, the whole producing a tree-like or dendritic effect.[23] These gills appear to be of some importance in respiration—although they are not thus essential[24]—and we often see a nymph swinging its abdomen from side to side as if intent on getting all the oxygen available. Furthermore, they greatly assist in locomotion, for fish-like, *M. leptodemas* sculls swiftly through the water for a short distance. When full-grown it measures about 17-18 millimeters long from head to the tip of the gills. The color is pale wood brown, or more or less grayish green, variegated somewhat zebra-like with darker markings (Plate XIII, 81). The wing pads have attained a considerable length and some of the chief veins are discernible. In due time it ceases to feed, the wing pads now somewhat swollen stand a little apart (Plate XIII, 79, for *M. hawai-*

[23] This type of gill is referred to by Tillyard (1917) as a Vertical Lamella of the Agrionid form, as distinguished from that of the Lestid form. Tillyard makes four subgroups here, showing as many phylogenetic stages in these Agrionid Lamellar gills, which he considers as descended from an original two-jointed gill. The gills of *M. leptodemas* appear to fit well into his third or γ group, the subnodate vertical Lamella, where the originally two-jointed condition is indicated only by a somewhat thicker zone at the base and the outer limits of which are delimited by a slightly different shade and the "stoppng short of the cuticular spines at the point where the node once was" (Plate XIV, 83, A—A).

[24] Dr. C. H. Kennedy (Ohio Journ. Science, XXI. No. 1, Nov. 1920, on page 23) writes as follows: "The primitive method of breathing in the Odonate orders seems to have been rectal because that is the method in the Anisoptera and in the first two instars in Zygopterous nniads. Also any Zygopterous naiad lives normally by rectal breathing after the external gills have been removed."

iense) and we may sometimes see this nymph with the fore end of the body partly out of water. Finally, it creeps up some plant, branch or boulder, the skin of its head and thorax splits above, and the relatively stubby adult, pale and soft, crawls out and rests on or near this nymphal exuviae, the wings and abdomen develop to their proper length and the integument becomes firm and in time assumes the adult coloration. But its first flights on delicate silvery wings are rather feeble and thus often fraught with danger and some time must elapse before it is really a capable flyer.

The single individual, a female, that was reared from the egg stage, developed as follows: Egg laid probably March 1, egg hatched March 12, adult issued June 30, totalling a period of four months.

The nymph of *Megalagrion leptodemas* is thoroughly aquatic, its thin leaf-like gills—which are subject to some variation—precluding any other sort of existence. It lives rather openly in the water, resting on shallow shelving bottoms, on submerged leaves, rootlets or among filamentous green algae. It is common in Hering Valley, dwelling in stream pools and in those which during a dry spell have become cut off from the main body of the stream, thereby affording breeding places for the night mosquito (*Culex quinquefasciatus* Say) and improving conditions perhaps for the larvae of midges (Chironomidae) that so often construct protective tubes upon the old *kukui* leaves that bestrew the water. In one such pool measuring 2 by 4 feet and nowhere deeper than 6 or 7 inches, I counted, from one position, 21 *M. leptodemas* nymphs.[25] Most of these graceful insects were resting lightly and in a more or less horizontal position—except for the rather up-curved abdomen—on old, shallowly immersed leaves. In several instances, the gill tips touched the surface film of water or broke through it.

My few dissections of the crop and gizzard of *leptodemas* nymphs of medium to large size, showed that they fed on mosquito larvae, on the young of midges (Chironomidae) probably mainly *Tanytarsus*—the pale green adults of which are often seen hovering in swarms over the water—and to a less extent on the semi-aquatic larva of one or more species of cranefly (Limnobiidae). In one instance, a copepod crustacean had been eaten. Quite young nymphs probably devour Protozoa and tiny Crustacea.

[25] October 8, 1933.

The nymph of this damselfly greatly resembles that of *M. xanthomelas*, an insect of much wider distribution. In both of these species the setae or bristles on the median and lateral lobes of the labium are better developed than in other Hawaiian species examined (See Plate XVI, 101 and 104).

M. leptodemas appears to be found only on the Island of Oahu.

Megalagrion xanthomelas Selys.

Selys, Synop. Agrionines, légion Agrion, p. 174.

McLachlan, Ann. and Mag. Nat. Hist. (5), XII, p. 232, 1883.

This is another of our smaller damselflies, more stout of form than *leptodemas* and of much wider distribution, probably occurring on all the larger islands. It commonly breeds in stagnant waters of the lowlands and is sometimes found in Honolulu gargens. But it may occur also at higher levels, Perkins (1913) having observed it in Kona, Hawaii, " . . . about stagnant pools up to an elevation of about 3,000 feet." The writer's occasional field studies on this little damselfly were made chiefly at some of the sugar plantation reservoirs of Waianae Company, Oahu, from

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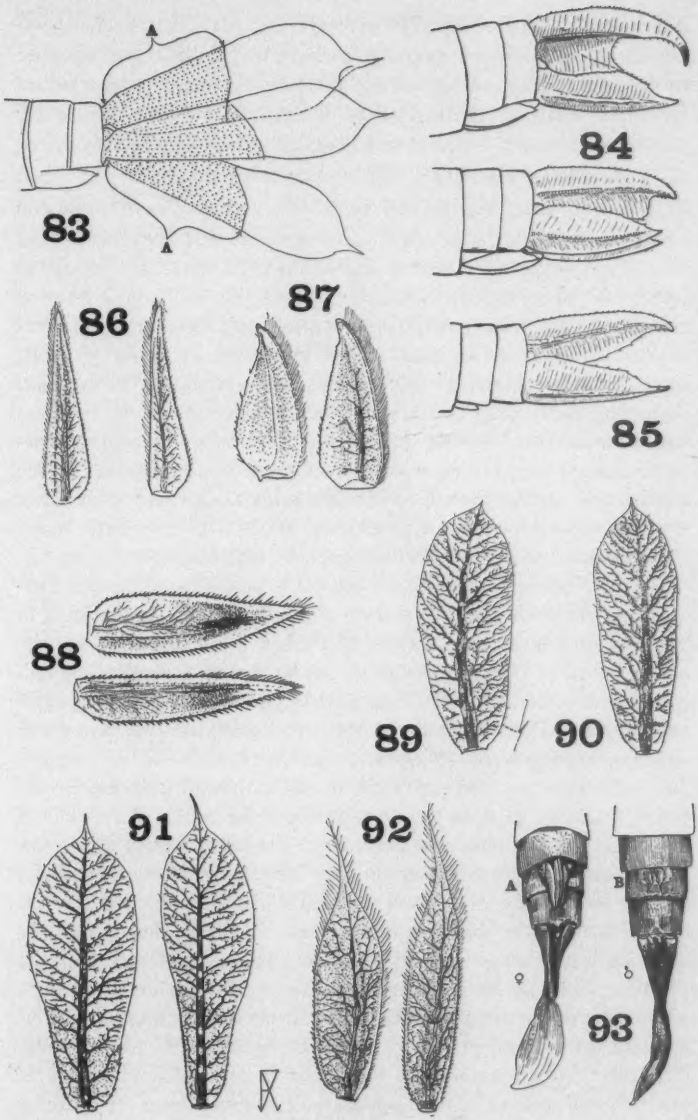
XIV

MEGALAGRION

Explanation of Plate

83. *M. leptodemas*, side view of the three caudal gills. The stippled basal portion at A A represents a somewhat thicker and slightly duskier area. From the Waianae Mts., Oahu.
84, 85. *M. koelense*, or *asteliae*, to show variation in the caudal gills. 84 last, 85 probably penultimate stage. From *Freycinetia* plants in the mountains behind Honolulu.
86. *M. hawaiiense*, median and a lateral caudal gill. Near Honolulu.
87. *M. amaurodytum* race *waianaeanum*, median and a lateral caudal gill. From *Astelia* lily, Waianae Mts., Oahu. There is considerable variation among these gills.
88. *M. oceanicum*, caudal gills.
89, 90. *M. xanthomelas*: 89, median, 90, lateral caudal gill. Waianae lowlands, Oahu.
91. *M. leptodemas*, median and a lateral caudal gill. Near Honolulu.
92. *M. nigrohamatum* race *nigrolineatum*, median and a lateral caudal gill.
93. *M. xanthomelas*, extremity of two nymphal skins from which adults have issued; female and male. The ovipositor sheaths of the female show at A, while the valvules of the genital pore of the male show at B.



Megalagrion

February to April, 1935. These reservoirs, particularly when containing no fish (top-minnows) harbored a considerable number though not a great variety of aquatic and semi-aquatic insects and of other small organisms. And where these bodies of water abounded in fish, a dense covering and flooring over certain areas, of green algae furnished a fair shelter from these fish for much aquatic life. One newly-filled reservoir, then without noticeable water-plant growth, contained many drowned and decaying sedges (*Cyperus*) from the more or less submerged stems and heads of which waved gracefully with the ripples the short, pale brown, gelatinous egg-strings of the common mosquito-like midge, *Chironomus hawaiiensis* Grimshaw. The hundreds, or probably thousands of such egg-strings soon produced a myriad tiny larvae that, sheltering themselves in stationary tubes of mud and debris spun together, increased in size and assumed their blood-worm appearance. These midge larvae, sometimes with those of a smaller midge species and the larvae of *Culex* mosquitoes, together with other organisms such as minute Crustacea—the swift jerky little tailed Copepoda and the active chubby clam-like Ostracoda—constitute in very great measure the food of the larger aquatics—*Pantala, Tramea* and *Anax* dragonflies and of our little damselfly, all quick to take advantage of these waters of plenty. Sometimes we see the savage larva of *Rhantus pacificus,* our largest water beetle—though of modest size—in the cement outlets or adjoining pools, while nearly everywhere along the shore or on mats of algae are small surface-running bugs—*Mesovelia* and *Microvelia*—active, watchful and rapacious. *Microvelia* is known to be quite destructive to tender insects that float on, or issue from the water. *Mesovelia,* a good deal larger, is likewise predatory. Common also on alga mats, slower and less aggressive, though frequently attempting short flights, is the tiny *Merragata* bug. The back-swimming *Buenoa* bug of predacious habit generally keeps in companies some little distance beneath the surface of shaded waters and maintains its position there by an occasional stroke of its oar-like hind legs, while back up on the muddy bottom, a trichocorixid bug, a lover of alkaline waters and probably chiefly a vegetarian, is to be found. The alert brown anthomyid fly *Lispa metatarsalis* Thomson of lowland and upland, is carnivorous and common here on shore or alga mat, while the lank, pale gray dolichopodid fly *Hydrophorus*

pacificus Van Duzee frequents the muddy shore or performs actively upon the surface film.

Such a *biota* or animal association, but incompletely sketched here, fluctuates for better or for worse, in the struggle for existence among its members and, with the introduction into its waters of such active and voracious feeders as mosquito fish, suffers greatly. And thus our lowland damselfly may be numerous or uncommon here as conditions are favorable or adverse to its existence. It can to a degree however, cope with difficult conditions. It is a low flyer and while skimming over the water is not liable to capture by its larger relatives, the immigrant dragonflies that fly higher.[26] It lays a large number of eggs, of which perhaps, the more exposed ones may suffer parasitism by a tiny wasp. Finally, the habit of the nymph of resting quietly among the green algae *Potomogeton* and other fine water plants that it so often resembles in color, affords it a measure of protection.

The adult damselflies could be seen in numbers in April at a certain fishless reservoir, along the shallows of which were more or less immersed plants of the succulent *honohono* (*Commelina nudiflora* Linn.) and of the more plentiful *Marsilia villosa* Kaulf. (*Rhizocarpeae*), a curious little herb with slender petioles terminating in several ribless leaflets that resemble somewhat those of a clover or of an oxalis. Female damselflies in tandem with their mates were inserting eggs—one for every puncture—into these plants. In the several cases observed the eggs were laid a little beneath the surface of the water, one female pushing her abdomen therein for full three-fourths its length. During oviposition the male, retaining with his terminal claspers his hold on the thorax of his mate, grasps with his legs the leaf or stem that extends above or beyond her or, where such support is lacking, assumes a rigid upright position, and may then occasionally flutter his wings in support. The eggs were found imbedded in the slender petioles of *Marsilia* and in the stems of *Commelina*. They are but shallowly inserted and lie almost parallel to the plant surface and are quite frequently exposed at their darker, pointed head end for full one-fifth of their length, the insertion hole being large. When the egg

[26] Needham and Heywood (A Handbook of the Dragonflies of North America, pp. 21-22, 1929) show that dragonflies and damselflies fly at different levels—". . . the big darners highest, the little blues lowest . . ." Thus, the smaller, weaker kinds are much protected from aerial attack by their low flight.

is in the thin *Commelina* leaf it produces a bulge on the upper and lower surfaces. A number of eggs may be laid at one time; they are not without order, all pointing in the same general direction and, when inserted in a leaf, the aggregate produces a sort of wide, stream effect. The egg is fairly stout, about 0.98 millimeters long, and except for the dusky pointed head end, a sort of pale amber color. The same plant stems or petioles that harbor these *Megalagrion* eggs, may also contain the eggs of the large green darner dragonfly *Anax junius* of the lowlands.

M. xanthomelas eggs laid in plant tissue on February 17—and possibly earlier—produced on March 9, tiny, nearly transparent nymphs bearing the usual three long and thinly hairy, spike-like caudal gills (as in 76, Plate XII). No such young were reared through to maturity, but a number of the nymphs of various sizes were secured, chiefly among green water plants. Many of these nymphs were of a greenish color—while others—that may have been in a different environment were dark brown to almost blackish. They are excellent short-distance swimmers. Of somewhat stouter form than *M. leptodemas,* the pigmented caudal gills are comparatively shorter and broader particularly towards the base (compare Figs. 89 and 90 with 91, Plate XIV). In addition, *M. xanthomelas* has the better developed setae on the median and the lateral lobes of the labium, of the two (Plate XVI, 104). A full-grown *xanthomelas* nymph measures about 18 millimeters long to the extremity of the gills.

Seventeen *xanthomelas* nymphs were taken out of a reservoir teeming with top-minnows, but affording some protection to

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XV

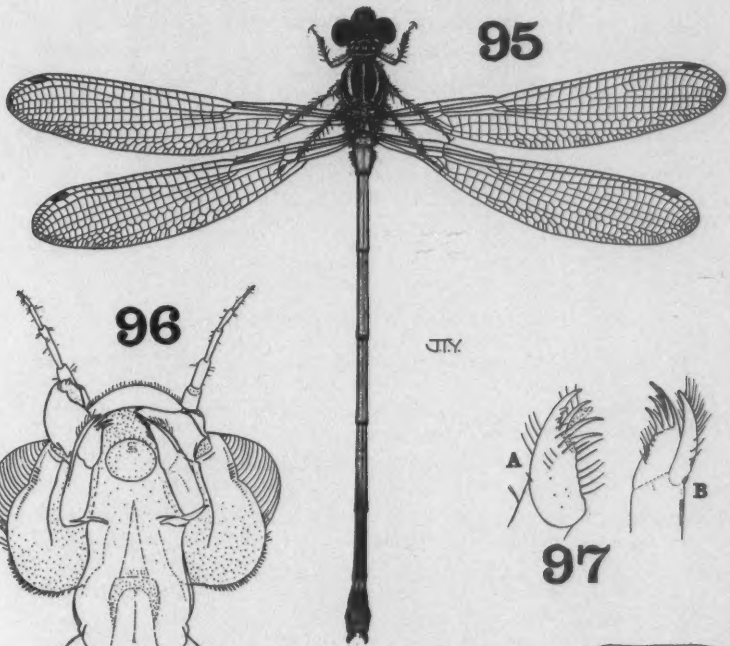
MEGALAGRION

Explanation of Plate

94. *M. oceanicum,* gizzard and crop of a nymph containing remains of numerous *Tanytarsus* midge larvae.
95. *M. oceanicum,* male. Wing expanse 58 mm.
96. *M.* probably *blackburni,* penultimate stage nymph, showing underside of head with labium pulled back. The mental setae are not indicated. Akaka Falls, Hawaii.
97. A and B, Two views of maxillae (in part) of Fig. 96.
98. *M. oceanicum.* Gizzard and crop of a nymph containing remains of *Tanytarsus* midge larvae. At T, are teeth of the gizzard.

94

J.T.Y.



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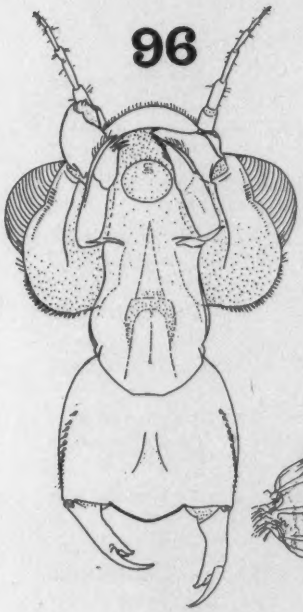

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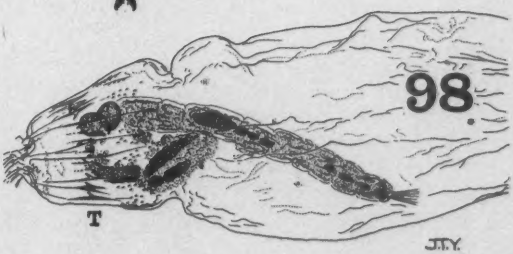


98

J.T.Y.

Megalagrion

smaller creatures in the dense growths of the green *Enteromorpha* algae. The alimentary tracts of these nymphs were dissected to find out what had been eaten, but as is usual among our damselfly nymphs, the findings were not very satisfactory. Some of the gut contents could not be identified. However, three had remains of nematocerous fly larvae, probably Chironomidae, three others had eaten 2, 2 and 1 oribatid mites, respectively, another contained what appeared to be part of a fly pupa, while the remaining 10 revealed some fine unrecognizable material, or were practically empty.

Several adults were reared from last-stage nymphs—two of these issued at about the noon hour, while a third one came out a little before 3:00 P.M.

XVI

MEGALAGRION

Explanation of Plate

99. *M.* probably *nigrohamatum*, underside of head of nymph. The mentum or free end of the "mask" or labium covers almost the entire underside, a small portion of the cheeks or genae and eyes being visible. From East Molokai Mts.

100. *M. nigrohamatum* race *nigrolineatum*, last stage nymph. The head is in a slightly different position from Fig. 99.

101. *M. leptodemas*, last stage nymph. Underside of head with mask unfolded. ms, setae of median lobe; ls, setae of lateral lobe. Near Honolulu.

102. *M. hawaiiense*, last stage nymph, underside of head. Near Honolulu.

103. *M. amaurodytum* race *waianaeanum*, last stage nymph, underside of head. From *Astelia* lily leaf bases, Mt. Kalena, Waianae Range, Oahu.

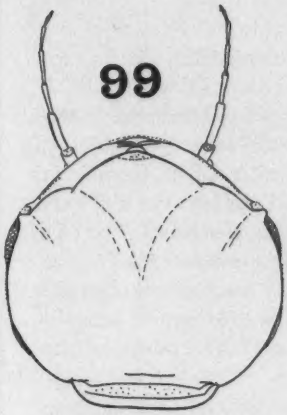
104. *M. xanthomelas*, last stage nymph, to show inner side of mentum of labium or "mask" bearing setae of the median and of the lateral lobes. Lowlands of Waianae, Oahu.

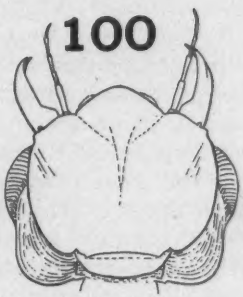
105. *M.* probably *nigrohamatum*, nymph, showing portion of wing pad base infested by young water mites. East Molokai Mts.

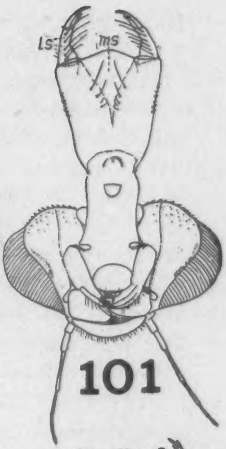
106. Water mite from Fig. 105, more enlarged.

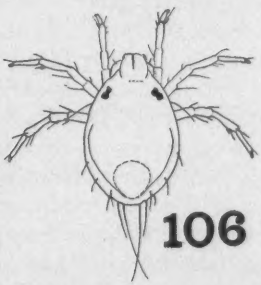
107. *M. amaurodytum* race *waianaeanum*, nymphal shell from which adult (Fig. 108) has issued. Length 17.25 mm. Mt. Kaala, Oahu.

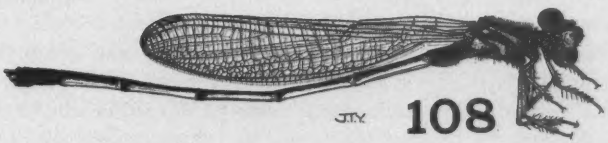
108. *M. amaurodytum* race *waianaeanum*, male. Issued from nymphal shell of Fig. 107. Length 42 mm. Ex *Astelia* lily.











Megalagrion

Megalagrion nigrohamatum (Blackburn).

(Ann. and Mag. Nat. Hist. (5) XIV, p. 415, 1884, and the race **nigrolineatum** Perkins, Fauna Hawaiiensis II, p. 65, 1899.

In the typical form *M. nigrohamatum* from Maui and Molokai, the knees of the legs are black, while in the race *nigrolineatum*, from Oahu and itself on the average a smaller insect, there is in addition, a black line along the upper side of the femora. Dr. Perkins' observations on this insect (Fauna Hawaiiensis II, p. 65) are very apt and are as follows: "The bright yellow face and the colour of the eyes, which are bright green or turquoise blue on the lower half, and red on the upper, give this species a most remarkable appearance when flying around streams. The colour of the eyes fades after death."

This insect is one of our common species and is to be seen along streams from near sea-level to 2,400 ft. or more, above. Males and females are frequently observed in tandem, the female having then been noticed inserting her eggs—or attempting to—in plant tissue in running water, and I suspect that she also lays eggs unattended and that she places them above water as well.

On East Molokai at an altitude of about 2,000 ft., what certainly must have been the nymph of this *Megalagrion* was abundant in the clear and cool waters of the Moaula stream and one of its tributaries. Here in late November 1933, the dull brown nymphs could be found clinging to the lower sides of stones that were more or less submerged and, by suddenly lifting up such stones, could be captured. In the Hering and Haleauau Valleys, Oahu, nymphs of the race *nigrolineatum* could likewise be found under stones but occurred also among masses of algae in running or in quiet waters. This nymph then, favors a concealed existence, its rather squat form suggesting a certain environment. It is noticeable chiefly for its large brown head—with the usual pale ocellar marks —and the particularly wide labium, the terminal or exposed underside of which, of a rich brown color is in striking contrast to the paler underside of thorax and abdomen. This folded labium when viewed from beneath, conceals almost the entire head (Plate XVI, 99 and 100).

The lateral lobes each bear a single good-sized bristle, or more rarely, an accompanying small one. The three caudal gills are not so leaflike as in the preceding two species; but form nevertheless

efficient swimming organs. They are long, relatively hairy (Plate XIV, 92) and while definitely 4-angled, tend to be soft, swollen and sac-like for a large part of their length, and somewhat flexible and wrinkled for their slender distal portion. The two entering tracheae of each gill are rather well apart, right and left, for some distance.

If one of these nymphs be placed again in water it will quickly swim to some object and flatten itself thereto.

The very few dissections of alimentary tracts of *nigrohamatum* nymphs from East Molokai (November 1933) showed that they had fed largely on the larvae of chironomid flies of the *Tanytarsus* group. One had eaten what appeared to be a small lepidopterous case-bearer together with a portion of its case. Near Honolulu a specimen in an upland pool containing *Culex* mosquito larvae had devoured some of these.

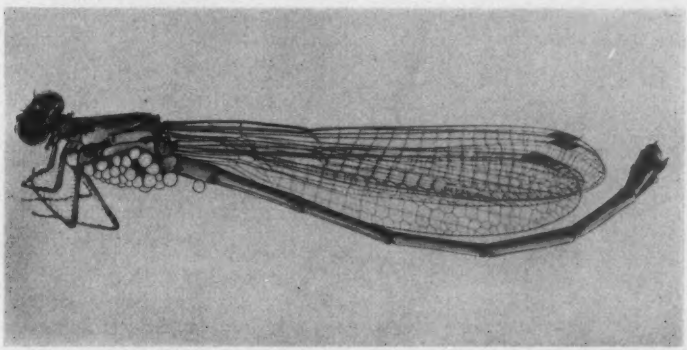


Fig. 5. *Megalagrion* sp., female with thorax and base of abdomen infested with mites or acari. Mountain View, Hawaii.

Clustered about the wing bases of one of these nymphs from the mountains of East Molokai were a number of six-legged mites (Plate XVI, 105 and 106) very much suggesting young *Arrhenurus* (Hydracarina). Of *Arrhenurus* sp., Garman, P. (Bull. Ill. State Lab. XII, Art. IV, pp. 441-442, 1917) writes the following on mainland species: "A mite, *Arrhenurus* sp., is a common external parasite of the nymph. At the time of emergence of the adult, the mite migrates from the nymph to the adult and is carried about by the latter until it is nearly mature, when it escapes again

into the water for the final stage." Text fig. 5 shows an adult *Megalagrion* species, collected at Mountain View, Hawaii, well loaded with closely packed subspherical mites of a brown color. Such mites have also been found on *M. blackburni* collected on Maui (P. H. Timberlake), and on *M. calliphya* collected on Lanai (R. L. Usinger), and they occur also on *Anax strenuus* (R. L. Usinger). Worthy of note here is a paper by Campion, F. W. and H., entitled: "Notes on Dragonfly Parasites (Larval Watermites, Entomologist, 42, pp. 242-246, 1909).

Megalagrion oceanicum (McLach.) (Ann. and Mag. Nat. Hist. (5) XII, p. 239, 1883). One male, "Oahu at no great elevation above the sea".

Mr. R. McLachlan (1883) in characterizing the genus *Megalagrion,* writes the following, pp. 237-238: "I have established this division for the reception of two of the most magnificent species of the Légion Agrion hitherto discovered". The species referred to are *M. blackburni* and *M. oceanicum* (Pl. XV, 95 ♂). Later, Perkins (1913) added a third species, *M. heterogamias* from Kauai to the group. These are our largest damselflies and the most conspicuous. They often measure three inches or more across expanded wings and the males and sometimes the females are very striking because of the bright red color of the abdomen. They are certainly among the first insects to be noticed by the casual observer who chances to wander about woodland streams; and in the water itself I have found that the nymph *M. oceanicum* is usually the dominant species.

The female *M. oceanicum* usually in tandem, inserts her eggs in the leaves, stems or roots of plants growing in or very near the water. The plants observed to be thus utilized by this insect were *honohono* (*Commelina nudiflora*) and the moon vine (*Ipomoea bona-nox* L.).[27] Eggs recently inserted are inconspicuous, but the puncture scars soon admit decay so that the leaf or stem assumes a densely freckled appearance. The writer recollects in Hering

[27] Other plants so used by forest-stream damselflies on Oahu are, Job's Tears (*Coix lachryma-jobi* L.), *taro* (*Colocasia antiquorum* Schott, var. *esculenta* Schott), the tender tip of a young banana (*Musa*) leaf, and a species of ginger (Zingiberaceae). In the foliage of *Commelina nudiflora* (Plate XII, 74 and 77) and *Ipomoea bona-nox* damselfly eggs may be found literally in thousands though often very heavily parasitized by a tiny *Anagrus* wasp. The identity of these eggs other than being those of damselflies, was usually not determined; the writer believes however, that they were mainly those of *M. nigrolineatum* and *M. oceanicum.* Since these half dozen species of plants are usually regarded as having reached the Hawaiian Islands within historic times, it would be interesting to speculate on what native plants served as repositories for our damselfly eggs in ancient times.

Valley,[28] a tiny and shallow rapids tressed almost mat-like with the parallel rootlets of the moon vine that, extending along the rocky bed of the stream, united to ascend as a cord-like liana, a great *kukui* tree, to leaf out high up among the branches. Three pairs of *Megalagrion oceanicum* were perched on and about these more or less submerged rootlets laying their eggs. Some of these rootlets upon being pulled out and examined, were found to be literally crammed with damselfly eggs easily discerned through the semi-transparent tissues. Ovipositions of an earlier period were visible from a distance of several feet as brownish spots or blotched areas on the rootlets. At another date, a female *oceanicum,* likewise in tandem, was observed rapidly placing her eggs in the upper surface of a *Commelina* leaf above water. Here the time intervals between egg insertions were as little as six seconds.

The young nymphs, on emerging from the eggs if not already in the water, ordinarily make their way into it.[29] They appear to develop rather slowly although the characteristic caudal gill pattern, i.e., a dark blotch before their pale tip (Plate XIV, 88) is apparent when the nymphs are quite young. As they increase in size, these gills become somewhat wider and finely saw-edged and fringed with bristle-like hairs that become longer towards the tip of the gills. These gills are tough and never develop into the efficient leaf-like sculling organs characteristic of the species already discussed. And here for the first time we have a damselfly that while always keeping very moist, often ventures out of water —a habit which does not favor delicate gills. *M. oceanicum* and its relative *M. blackburni* of Hawaii, Maui, Molokai and Lanai, and no doubt *heterogamias* of Kauai, are moderately good swimmers, although their sturdy form seems better suited for creeping among rootlets, algae, in steep running water, shallow pebbly bottoms, up a dripping bank or among stones, under dead leaves in water and in little pockets of water at the bottom of a gentle waterfall.[30] And thus indeed *M. oceanicum* lives under such varied conditions. When quite small it is often found among algae and diatoms in shallow running water, but large individuals may sometimes be

[28] October 1, 1933.

[29] However, Mr. O. H. Swezey has collected *Megalagrion* sp. eggs in *Datura* leaves that were quite far removed from water at the time, so that the emerging young would surely perish.

[30] Perkins (Fauna Hawaiiensis, Introduction) has found *M. heterogamias* P. among wet decaying leaves, and *M. oceanicum* "in wet moss on rocks in stream beds".

disturbed, filmed over with water, several feet up a rock bank and alongside swiftly running water, or lodged in little chinks or notches there. The food of the nymph consists of the larvae of the lower flies of the families Chironomidae, Ceratopogonidae and the subaquatic Limnobiidae, with an occasional Ephydridae and other small creatures. Among the green algae (*Cladophora,* etc.) in or alongside small rapids and falls, the prey may consist of the ceratopogonid *Dasyhelea hawaiiensis* MacFie the larvae of which are orange colored and snake-like, the larva of *Tanytarsus* the little green midge, with an occasional larva of the dusky and erratic *Telmatogeton* (= *Charadromyia*) fly.[31] Where the damselfly nymphs frequent wet rocks, the larvae of crane flies (Limnobiidae) form an important part of their menu. Figures 94 and 98, Plate XV, are drawings from stained slide mounts of the crop and gizzard (showing the gizzard teeth in Fig. 98, T) of two nymphs of *M. oceanicum,* from Hering Valley, Honolulu. The crop and gizzard of Fig. 98, T, are seen to contain as recognizable food, two heads and most of the body, including the hair tuft at the tail end, of the larva of *Tanytarsus* (Chironomidae); in Fig. 94 twenty-eight heads and several bodies of these *Tanytarsus* are recognizable. Occasionally a smaller damselfly nymph falls a victim to *M. oceanicum* and *blackburni,* and in the crops of the former a small moth caterpillar, collembolous insects and oribatid mites have also been found. Tiny crustaceans must also be included in the bill-of-fare of these insects, and occasionally an adult water-loving fly such as a dolichopodid, or a little ephydrid fly (*Scatella*) is devoured. In the clear shallow current of a stream back of Honolulu, the writer once saw a large nymph of *M. oceanicum* devouring a small earthworm (*oligochaete*) at the other extremity of which a second though quite small *Megalagrion* was holding fast. A rather small *M. oceanicum* nymph, taken from a dripping wet bank, well browned with water-soaked diatomaceous plants, in the Waianae Range, Sept. 16, 1933, was found to have eaten a small larva of the common water beetle, *Limnoxenus semicylindricus* (Sharp).

M. oceanicum may be easily reared and studied in a shallow dish partly filled with water containing a few dead leaves, some

[31] On East Molokai remains of an adult *Telmatogeton* fly were found in the crop of *M. blackburni,* a close relative of *oceanicum.*

algae and a *Commelina* plant stem. A large specimen which was secured near Honolulu in August, 1933, moulted at the surface of the water on the afternoon of August 12, and when first seen thereafter, was a yellowish or creamy white except for the dark eyes. It seemed more nocturnal than diurnal, sometimes appearing in the evening partly exposed at the surface of the water where it lay atop some debris, or it crawled up a stick so that its head was out of water. It was easily fed by means of tweezers, and when mosquito wrigglers were thus offered it, did not hesitate to snap them up, consuming nine such in rather quick succession. Late in the afternoon of Sept. 8, when this *oceanicum* lay on some litter near the surface of the water and its back well exposed to air, I fed it with the forceps some larvae and pupae of mosquitoes. At the sight of these tidbits it became quite excited, made a short jerky run at a proffered morsel and, upon my gentle drawing away of the latter, was induced to leave its horizontal position and clamber up a stick until quite out of water, and then to seize the young mosquito held before it. Later on this dusky nymph refused food and could be seen clinging to an erect stick, so that only the tips of the wing cases reached the water. On September 19 or 20, it crawled to about 3½ inches above the surface and hatched into an adult. Thus, the time between the moult into the last nymphal stage and the moult into the adult insect, was about 5½ weeks.

Comparing the larva of *M. oceanicum* (Plate XIII, 78) with those of other Oahuan species, we note that this variegated dusky brownish, or more or less olive greenish insect, apart from its larger size—up to 25 mm. long to the extremity of the gills—and the form of the gills, has a relatively narrow head. The labium is wide, its lateral lobes bear usually two small bristles on their inner side near the apex and there are some quite small bristles about the middle inside surface of the median lobe.

The adult *M. oceanicum* and *blackburni* are, among insects, rather bold and aggressive. *M. oceanicum* perched on a particular twig or rock portion in the canyon, darts out from time to time at some insect and quarrels with its damselfly neighbors. It will engage in a scuffle with the dragonfly *Nesogonia blackburni,* a larger and more powerful insect, but sometimes it falls a victim to *Anax strenuus,* the watchful and swift flying giant dragonfly that easily snatches it out of the air.

Megalagrion hawaiiense (McLachlan).

Agrion (?) *hawaiiense* McLachlan, R., Ann. and Mag. Nat. Hist. (5) XII, pp. 232-234, 1883. "Oahu, at no great elevation above the sea."

Agrion calverti Perkins, R. C. L. Fauna Hawaiiensis, II, Pt. VI, pp. 694-695, 1910.

This is a damselfly of medium size that is largely metallic green in color, there being also some pale yellow on the thorax and very narrow bands of that color on the abdomen. A reared male from the Waianae Mts. has a good deal of yellow on the abdomen. It inhabits the canyons of both mountain ranges of Oahu, where I have found it at an elevation of from less than 1,000 ft. to nearly 4,000 ft. above the level of the sea.

Most of the field studies on this insect were made in the well-shaded Hering Valley, Makiki, in the hills immediately behind Honolulu. Ovipositions were noted in March, 1931, and particularly in May 1935, when the bright-hued flowers of the Mountain Apple or *Ohia ai* (*Eugenia malaccensis* Linn.) were clustered about the branches, or here and there as fallen stamens, littered the ground with a thin magenta carpet. Of the dozen female *hawaiiense* observed as being thus occupied, none was accompanied by a male. Eggs were inserted in a decayed, water-soaked leaf midrib that lay in exceedingly shallow water just above a wet rocky bank on which nymphs of *M. hawaiiense* and *M. oceanicum* were often found; another female probed some dead vegetable tissue in shallow running water, and two others likewise investigated wet moss alongside. A specimen of what appeared to be also *hawaiiense* inserted a few eggs within about an inch from the wet ground, in the delicate little stem of a seedling plant. A few *hawaiiense* eggs dissected out of a decayed leaf midrib measured 0.85 millimeters in length. None was reared through to maturity, but from time to time numerous *hawaiiense* nymphs of various ages were collected and a series of adult damselflies reared from wellgrown nymphs. These nymphs are of particular interest since they may be largely terrestrial in habit, although very young individuals were not seen out of a water film. They are comparatively indifferent swimmers, as their dagger-shaped tail gills (Plate XIV, 86) would indicate Specimens may be a generally dark brown color, with the usual lighter spots on the head, and obscure bands on the legs, a pale

area atop the thorax, some marks on the abdomen and the tail gills with a more or less well-defined dark area before their pale tips, or the insects may be largely paler wood brown, that shade being particularly noticeable on the thorax and dorsal part of the abdomen. Mature nymphs are up to 18 mm. long to the tip of the caudal gills, and they somewhat suggest tiny rough-coated lizards (Plate XIII, 79).

A favorite haunt of these nymphs in Hering Valley behind Honolulu, was a steep little rocky bank that, except in very dry periods, remained constantly wet from a very small flow. The face of this bank, more or less irregular, and with here and there some fine aquatic vegetation, was also a breeding place for two species of crane flies, the larvae of which dwelt in spun tubes, in cracks, or under dead leaves, for the little speckle-wing *Scatella* flies and from time to time, for the tiny *Forcipomyia ingrami* midge. Stolid *Scatella* sometimes perched in numbers on this wet bank, and nimble little dolichopodid flies explored the slope. Active staphylinid beetles (*Philonthus haddeni* Bierig)[32] ran about or were concealed under leaves. Above and below, were tiny shallow depressions containing water and plant debris, largely *kukui* twigs and leaves. These rock-creeping *Megalagrion* nymphs were to be found exposed on the face of the rock, squat upon a shining water-soaked bed of brown diatoms, among wet debris, and under old *kukui* (*Aleurites moluccana*) leaves. Sometimes a moist nymph would be standing free of any water film, or its form would cause a hump in a very thin sheet of flowing water. The large *M. oceanicum* also shared this environment, but it is a definitely more aquatic insect. Both *hawaiiense* and *oceanicum* may occasionally be seen in mild sunlight with or without a thin sheet of water enveloping them. A *hawaiiense* nymph in the penultimate stage was secured on the wet rocky bed of a very steep little ravine beside the peak of Olympus, near Honolulu at an altitude of about 2,000 ft. There was no permanent water at this point, but some very tiny pools—one containing a *Copelatus* (*Liopterus*) *parvulus* beetle—had been formed in this region of heavy rainfall. Well behind the peak of Tantalus (Puu Lehua) at an elevation of over 1,000 ft. a number of rather pale brown *hawaiiense* nymphs were collected on March 10, 1935, along a tiny trickle and seepage of water on a steep

[32] Determined by Dr. Alexander Bierig.

slope, and that was for the most part concealed by a growth of *Commelina,* grass and other plants. I placed some of these nymphs in a cup of water where they proved to be very poor unwilling swimmers. They do however, occur in pools.

The nymph of *hawaiiense* feeds upon what the locality affords. Thus, dissections of the foregut of some of these rock-creeping insects taken from the steep little bank in Hering Valley showed that they fed very largely on the active cylindrical larvae of crane flies, *Limonia* (*Dicranomyia*) *grimshawi* (Alex.) and probably also on a smaller *L.* (*Dicranomyia*) sp. On two occasions a rock-creeping nymph was observed eating a cranefly larva. Aquatic oribatid mites are often consumed and *Scatella* flies, their larvae, and those of midges likewise form part of their food.

A note of November 19, 1933, may be of interest: Hering Valley, on a nearly horizontal part of a wet rock ledge adjoining the tiny stream, two large *hawaiiense* nymphs were walking about, even in the leaf-filtered sunlight. One of the pair, well raised on its legs, approached a small millipede (*Orthomorpha*) that was quiet save for the movement of a small group of its legs, and at which the nymph snapped in a half-hearted manner. A smaller nymph was seen on a wet and sloping rock nearby. Occasional wandering *Pheidole megacephala* ants sometimes attracted the attention of these *Megalagrion* nymphs, and remains of one of these ants were

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XVII

MEGALAGRION

Explanation of Plate

Figures of end of abdomen of adult males to show claspers, i.e., the superior appendages S and S′, and the inferior appendages I and I′. T indicates the dorsal or upper edge of the last abdominal segment. S′ indicates the superior appendage in nearly or quite in broadside view, as regards its inner surface.

109. *M. leptodemas,* Oahu.
110. *M. oceanicum,* Oahu.
111. *M. pacificum,* East Molokai.
112. *M. xanthomelas,* Oahu.
113. *M. amaurodytum* race *waianaeanum,* Oahu.
114. *M. koelense,* Oahu.
115. *M. nigrohamatum,* East Molokai.
116. *M. hawaiiense,* Oahu. A. with spine-like process.
117. *M. oahuense,* Oahu.

109

110

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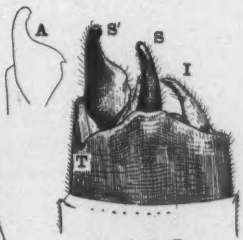

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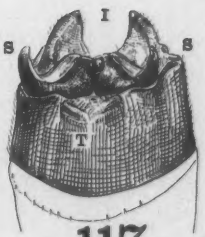

117

Megalagrion—end of abdomen of male adults.
T. indicates the dorsal side

found in the foregut of a large nymph. Jan. 14, 1934, other rock-creeping nymphs were seen on the wet rocks. Sometimes a nymph would have a film of water clinging to it, or it would be free of such. I placed a crane fly larva quite near a small damselfly nymph. The nymph seized this large larva but was unable to retain its grip. Not so however with a small water beetle (*Limnoxenus*) larva nearby. Although smaller than the fly larva, *Limnoxenus* seized it firmly in its sharp toothed jaws, and holding on bulldog-like, finally subdued it.

Eight partly-grown to last stage nymphs from the locality of March 10, behind the Peak of Tantalus, were dissected to find out what they had eaten, with the results as follows: one contained parts of three heads and tubercles of *Forcipomyia* sp. (*Ceratopogonidae*), the remnants of a small crustacean, probably *Philoscia,* and three oribatid mites; a second contained a young crustacean; the third a mite sp. and parts of a small crustacean; while the remaining five nymphs contained some fine undetermined material, or the crops were empty.

The lateral lobes of the labium of the *hawaiiense* nymph are provided with two moderately long bristles each, on their inner side, the first bristle being near the apex, the second slightly above the middle.[33] The bristles of the inner lobe are not conspicuous, there being a pair of more anterior bristle areas of a few shorter bristles, and a more posterior pair of areas of slightly longer bristles. The superior caudal appendages of the adult male may or may not have a small tooth on their lower side at the expanded portion (Plate XVII, 116 and A).

Sometimes we find a newly emerged damselfly, its body still pale and comparatively short, its wings yet silvery, resting on or near the skin that gave it birth and that clings so tenaciously to the boulder beside the stream. And close at hand, we might see a fully matured female *hawaiiense,* her slender abdomen showing dark metallic greenish and black with narrow and pale segmental bands, placing her eggs among wet plant debris in the shallowest of puddles.

M. hawaiiense is related to the generally larger and rather well distributed *M. deceptor* (McLach.).

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[33] A single nymph from 2,000 ft. elevation, windward Oahu, and that produced a rather light colored *M. hawaiiense* male has three well spaced bristles on the inner side of the lateral lobes.

Megalagrion deceptor (McLachlan).

Agrion deceptor Ann. and Mag. Nat. Hist., XII, p. 235, 1883. "All the Islands from Oahu to Hawaii inclusive (Perkins, 1913)."

This is a rather large damselfly that in size and coloration resembles a small specimen of *M. oceanicum*. In structure it is closely related to *M. hawaiiense*. It is at home well up in the mountains, extending up their slopes to an altitude of 6,000 ft. or more above sea-level and sometimes wandering far from the rocky canyon that gave it birth. Nymphs that seemed to be of this species were common in a small stream on the eastern slope of Mauna Kea, Hawaii, at an elevation of about 5,000 ft. above sea-level. About a dozen of these dagger-gilled nymphs showed from an examination of their foreguts that they had fed chiefly upon *Tanytarsus* fly larvae (Chironomidae) and oribatid mites.

Fig. 6. Several plants of *painiu* (*Astelia veratroides* Gaud., Liliaceae) growing in the mossy forest on Mt. Kaala, Waianae Range, Oahu, at an elevation of about 4,000 feet. Nymphs of the damselfly *Megalagrion amaurodytum* live at the leaf bases of this plant.

Megalagrion that breed among the leaf-bases of certain plants.

We have several species of damselflies, the larvae of which are plant-dwellers. They occur in the upland rain forests where they are attached particularly to the *Astelia* or *painiu* and to the *Freycinetia* or *ieie*. The *Astelia* is a native lily of semi-epiphytic habit that grows on the ground (Text fig. 6), on moss, or fern-laden branches and trunks of forest trees or upon similarly covered rocks. The sword-like leaves, almost silky white beneath, of the *Astelia* lily are strongly V-shaped in section at their bases where one leaf rather openly overlapping another along the stem, afford splendid retreats and hunting grounds—when the plant is sufficiently large—for the nymphs of *Megalagrion*. Commencing at a lower level, in a zone less moist than that in which the *Astelia* occurs, the climbing screw-pine or *ieie, Freycinetia arborea* Gaud. (Pandanaceae) is to be seen twining itself on trees or, in zones of low plant growth, lifting a graceful head of glossy sword-like leaves from a snake-like stem from among the vegetation (Text figs. 7 and 8). Likewise the leaves of the *ieie* lack petioles and overlap at their base, and likewise do they collect between themselves an assortment of dead leaves, twigs, humus, etc., among which are to be found many small organisms, the food supply of the damselfly nymphs. Of moisture there is usually plenty among the leaf bases, and the nymphs, particularly the small ones, are often filmed over with water. But, except under very rainy conditions, water does not persist there, nor indeed does the nymph appear ordinarily to require any but an occasional wetting.[34] Quite rarely, as observed by Mr. O. H. Swezey, a damselfly nymph may be found at the petiole bases of the common *ti* plant (*Cordyline terminalis* Kunth).

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[34] Hence the plant-dwelling nymphs of Hawaiian damselflies live under very different conditions than do those of the giant damselflies of tropical American forests where certain epiphytic species of the Bromeliaceae or pineapple family retain between many close-set leaf bases, an abundant and long-lasting, if not permanent supply of water in which the nymph, it seems, lives in a truly aquatic manner. These huge though slender damselflies slowly rising up or hovering, spectre-like in the forest, are one of the marvels of the insect world because of their excessive length of body, the abdomen sometimes exceeding five inches. In this connection it is appropriate to quote from Calvert's article "Studies on Costa Rican Odonata II—The Habits of the Plant-dwelling Larva of *Mecistogaster modestus*." (Entom. News, 22, 1911) on page 410, as follows: "The excessively long abdomen of the adults of *Mecistogaster* and its allies (*Megaloprepus, Microstigma, Pseudostigma, Anomisma*) may be a special adaptation to the life of their offspring in water-containing plants, since the abdomen of the larva of *M. modestus* is no longer proportionally, than in other Agrioinae. The space between the leaf of a bromeliad and the leaf next without decreases downward, and if *Mecistogaster's* eggs are deposited in the plant tissue in or near the contained water, in accordance with the general habit of Zygoptera, it would often be necessary for the female to reach far down into crevices possibly too narrow to admit of the entrance of her thorax and wings."

Even the wettest of our forests are, now and then, subject to dry spells, which, however, these plant-dwelling insects seem able to endure, and Dr. Perkins' observation (Fauna Hawaiiensis, II, Pt. I, p. 64, 1899) on the hardiness of these nymphs may well be quoted here, as follows: "These terrestrial nymphs are able to endure extreme drought. On one occasion when out shooting,

Fig. 7. *Ieie* or climbing screw-pine (*Freycinetia arborea* Gaud., Pandanaceae) growing on the crest of the Koolau Mountains behind Honolulu. The nymphs of several species of damselflies (*Megalagrion*) breed between the leaf bases of this plant. Elevation about 2,300 feet.

having no more convenient receptacle, I carried a number for the greater part of the day in an envelope. In the evening, although very dry, they were still quite lively. They were then placed in a tumbler of water, where they remained on the bottom, not being able to crawl up the sides. Here they remained for a day, apparently as happily as on dry land, when they were taken out and preserved."

The nymphs of three species of *Megalagrion* are plant-dwellers on Oahu, as follows: *M. amaurodytum* (Perk.) race *waianaeanum* (Perk.), *M. koelense* (Blackb.) and *M. asteliae* (Perk.).

These are closely related, more or less metallic black insects with some yellowish. *M. amaurodytum* race *waianaeanum* occurs on the high peaks of the Waianae Range, Oahu, where conditions are sufficiently moist for its nymph, which may be found between the leaf bases of *Astelia* and of *Freycinetia*. Eggs no doubt of this species were discovered in the midribs of *Freycinetia* leaves into which they had been inserted from the upper side. Nymphs were collected chiefly from winter to early summer, when they were found in several stages of growth. It is obvious, however, that both young and adults may be secured the year round. On February 9, 1930, the writer collected a number of nymphs from *Astelia* plants on Mt. Kaala, altitude 4,030 ft., the highest mountain on Oahu. These insects were either head down or head up between the bases, more commonly of the newer leaves, being partly or not in the little water there. The slender flightless cricket, *Leptogryllus forficulatus* (Brun.), were also plentiful in similar situations sometimes resting tête-à-tête with the damselfly nymphs. Some of these thickset nymphs were placed in water, in which they were awkward and appeared even uncomfortable. They could be induced to wriggle a little but really seemed unable to swim and they clung tenaciously to one's fingers as if fearing the element. The mature nymph is in general brownish or slightly greenish brown; wood brown on the back and dark along the sides of the abdomen. The short gills (Plate XIV, 87) are quite thick, more or less hair-fringed and finely to coarsely serrated on their lower edge. The median gill particularly is subject to considerable variation in this and in the other plant-dwellers that I have examined. It is most often falcate, sometimes considerably notched or emarginate below the sharp curved apex as though it had suffered injury there. This seems not to be the case, however, since bristles are present in such notches or emarginations (Plate XIV, 84 and 85, for *M. koelense* or *asteliae*).

A few adults were secured from these and other nymphs and, as is more usual with the Zygoptera, they issued in the morning.

The typical form, *M. amaurodytum,* was collected as nymphs in small numbers in late November 1933, from the fine *Astelia* plants in East Molokai at an altitude of over 2,000 ft. These nymphs—as measured from the front of the head to the extremity

of the gills—may attain a length of slightly over 20 mm. Their occasional pale green color may perhaps be due to a recent moult.

Megalagrion koelense (Blackb.) and *M. asteliae* (Perk.) are very closely allied species best separated by the rather slight differences in the male claspers. They average a little smaller than *M. amaurodytum. M. koelense* is found on Lanai, West Maui and Oahu; *M. asteliae* occurs on Oahu and Hawaii, and on Oahu may fly with *M. koelense.*

Fig. 8. More *ieie* vines (*Freycinetia arborea*) in the Koolau Mountains behind Honolulu. Elevation about 2,100 feet.

My field observations concern presumably only *M. koelense,* an insect conveniently found in the mountains behind Honolulu. The long narrow ridges that commence as buttresses from the edge of the city gradually attain higher altitudes, and then, rising more suddenly, merge into the serrated, knife-edged backbone of the range that drops so precipitously steep on its ribbed windward face. Among these moist heights then, from 2,000 to 3,100 feet above sea-level, a region of low, weathered vegetation, where sometimes occasional groups of the curious *Olapa* tree (*Cheirodendron*

platyphyllum Seem. Araliaceae) aspen-like, respond to the breeze by fluttering their broad shining leaves, with a noise like pattering raindrops, this damselfly is chiefly at home, its nymphs resting in the upright heads of the stout *ieie* vine, more rarely in *painiu,* and feeding upon convenient weaker neighbors of diverse groups that with it share the bases of the leaves.

Perkins has observed, in unpublished notes, this damselfly ovipositing in the leaves of the *ieie* (*Freycinetia*), and on March 24, 1935, I had that opportunity on Mt. Konahuanui, at an elevation of 3,100 ft. Here the *ieie* vine formed part of the vegetation that, on the one hand, clothing the great windward precipice with a dwarfish growth, reaches more generous proportions on the steep though more sheltered canyon slopes, on the other. Shortly before 10:00 a.m. a female damselfly was observed on a sharp ridge where many *ieie* vines raised their heads a foot or two above the ground. This chiefly bronzy-green and dull blackish insect, marked also with a little greenish yellow, would fly to one of the narrow, gracefully drooping *ieie* leaves that was situated rather outside in the whorl and alight on its sloping underside. Then she would feel about with the tip of her abdomen, the upper surface of the leaf immediately below her and rather near its base, and with abdomen extended cut slits directly in the midrib groove. One can see the end of her abdomen in muscular action, for the plant tissue is quite firm. The blade of the ovipositor (Plate XVIII, 121) is strongly saw-edged however, and punctures are soon made. She

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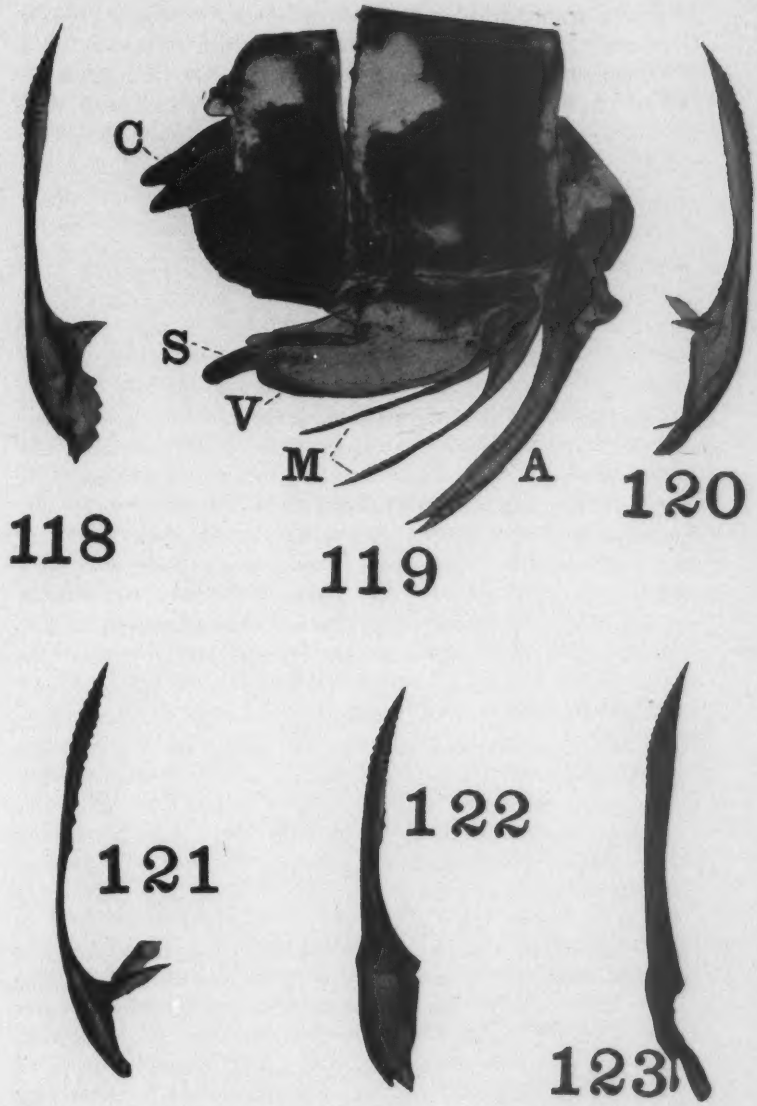
XVIII

MEGALAGRION—Ovipositors

Explanation of Plate

118. *M. hawaiiense,* one of the paired median processes. Near Honolulu.
119. *M. amaurodytum* race *waianaeanum,* extremity of abdomen, somewhat compressed, to show components of ovipositor. A, anterior processes; M, median processes; V, valve; S, style. C, superior anal appendages. Oahu.
120. *M. deceptor,* median process. Oahu.
121. *M. koelense,* or *asteliae,* median process. Konahuanui, Oahu.
122. *M. oceanicum,* median process. Near Honolulu.
123. *M. oahuense,* median process. Near Honolulu.

Photographs by W. Twigg-Smith.



Megalagrion-ovipositors

deposited a small set of eggs in this leaf, rested briefly on a nearby bush and then commenced operations on another *ieie* plant.

Oviposition by this species or by *M. asteliae,* was again observed late in the morning of June 2, 1935, on the rain-gauge summit of Lanihuli, 2,700 ft., that precipitous ridge guarding the left side of the Nuuanu Pali, Honolulu. The damselfly alighting on a *Freycinetia* leaf, hung from its edge and underside, and slowly backed down it until the extremity of the abdomen touching the upper surface of the leaf immediately below naturally settled in its lowest part, i.e., the wide groove in which the midrib is situated. Oviposition took place at two inches or a little more from the exposed base of the leaf. The eggs are laid in the midrib, usually in pairs (Plate XII, 75) as if she realizes the advantage of making a single puncture through the hard surface serve for two eggs. Thus, oviposition in this species or group differs—as far as my observations go—from that of our species of other groups which insert but one egg through each puncture. The scars of the egg-punctures soon dry as dirty whitish membranous scabs, while the form of the eggs show as two diverging streaks. The scab eventually falls off, thereby exposing the darker pointed extremity of the egg, and the tissues about it darken so that older ovipositions—of which there are often one or more series on several leaves of the same plant—are quite conspicuous. The egg of *M. koelense,* or of *asteliae* (Plate XII, 72) is of the usual form, pale amber brown, dark at the pointed end and measures about one millimeter in length. The several little egg-groups of March 24 were brought to the warm laboratory in leaf sections and kept moist in a salve tin. From them, three nymphs were produced on April 15, making an incubation period of 22 days. An egg that was laid sometime prior to the above lots was placed freely in the water where in ten days it hatched perfectly. In several instances the pronymphal, or first stage (Plate XII, 73) was observed. This is characterized by a conical head and by having the appendages—antennae, mouth-parts, legs and gills—bound immovably to the body by an outer skin. The duration of this pronymphal stage was not determined, but it is always very short. The active young nymph is already of stout form (Plate XII, 71) and when immersed in water may wriggle the body vigorously, its legs outspread, but swims thus

very poorly. It is able to walk upside down from the surface film, a little.

None of the nymphs was reared through from early life. From time to time however, specimens that were well along in the last instar were placed between the occasionally wetted leaf-bases of an *ieie* head or among moistened towel paper and the broad folded *ti* (*Cordyline*) leaves, and thus a number were successfully brought to maturity. These issued usually in the morning, often quite early. A case of morning emergence was also noted in the field. The nymph of *M. koelense,* like that of *M. amaurodytum* of the Waianae Range, is a very ordinary looking insect; squat and thick-set with short gills,[35] of which at least the median one is more or less falcate (Plate XIV, 84 and 85). The color is chiefly greenish and dull brownish, the abdomen being a sort of wood brown with a broad dark stripe along the sides. Other specimens may be very dark.

Nymphs that have reached full growth and have stopped feeding are characterized—as in other species—by the swollen thorax and wing cases. Such a nymph may measure up to about 17.75 mm. including the gills. The bristles of the lateral, and of the median lobes are as in *M. amaurodytum waianaeanum,* i.e., usually 5 for the laterals and a few quite small ones for the median lobe.

While this insect seems to prefer the high wet ridges, nymphs may also be found in *ieie* plants growing even as low perhaps, as 1,000 ft. Food supply and of course, moisture exist in less quantity there than at greater altitudes, where only, I believe, does the insect really thrive. *Pheidole* ants are no doubt inimical to it at low levels, as they are to other insects as well.

Several nymphs frequently occur on one plant.

As a considerable variety of small organisms—millipeds, Crustacea, Acarina, Mollusca, Insecta, etc.—habitually live and often breed, between the leaf bases of *Astelia* and *Freycinetia,* it follows that the bill-of-fare of our plant-dwelling damselfly nymphs may be far from monotonous. A study of the various organisms associated with these two plants is an undertaking of considerable magnitude.[36] Many of these forms are too large or otherwise

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[35] For a study of the morphology of the caudal gills of *M.* (=*Agrion*) *asteliae,* see Tillyard, R. J., Proc. Linn. Soc. New South Wales, 1917, xlii, on pages 103-106.

[36] In this connection the reader is referred to an article by O. H. Swezey in this issue.

unsuited as food for the *Megalagrion* nymphs and some indeed, may prey upon them, particularly when quite young.[87]

The crops and gizzards of a considerable number of these plant-dwelling nymphs were examined to determine what they had fed upon, with the following results:

M. amaurodytum, from East Molokai, 2,400 ft., Nov. 29, 1935.

In *Astelia*—

1—A larva?, remains of an amphipod crustacean, a number of fern sporangia.

2—Remains of amphipod crustacean, part of a fern sporangium.

M. amaurodytum waianacanum, from Waianae Mts., Oahu, 3,000-4,000 ft., April 19, 1931.

In *Astelia*—

1—Remains of a small spider.

2—Remains of a large oribatid mite (Acarina).

3—Portions of 3 very small amphipod Crustacea, 1 very small millipede part.

4—Small tortricid caterpillar (feeds on *Astelia*).

M. koelense probably Mt. Konahuanui, Oahu. 2,600-3,000 ft., March 24, 1935.

In *Freycinetia*—

1—Remains of a single little wasp (Mymaridae), probably *Polynema ciliata* Perk., parasitic in the eggs of the leafhopper, which oviposits in the leaves of *Freycinetia.*

2—Remains of a small crustacean, probably one of the Amphipoda.

3—Wasp remains—probably same as No. 1.

4—Parts of a small crustacean.

5—Wasp remains, probably same as No. 1.

6—Oribatid mite.

7—Mouth parts of a small homopterous bug.

8—Parts of a crustacean or a spider.

9—Mymarid wasp wing and parts of a small carabid beetle larva.

M. koelense, probably Mt. Olympus, Oahu, 2,000-2,400 ft., March 31, 1935.

In *Freycinetia*—

[87] High up in the Waianae Mountains, Oahu, in late June, 1935, the writer once saw a dark colored, crab-like spider that frequents the leaf bases of the *ieie,* with an apparently fully mature *M. amaurodytum* nymph in its grasp.

10—Dark leathery material with corneous piece, probably *Succinea* snail.

11—A brown mite (Acarina), part of *Succinea* ? shell, a small male nematocerous fly.

12—Small hymenopterous parasite, parts of a small carabid beetle larva, part of a small crustacean.

13—A holoptic, well-beaked head of probably a forcipomyiid fly (Ceratopogonidae).

14—Small hymenopterous parasite.

15—A collembolous insect, head of nematocerous fly larva, parts of a small isopod crustacean.

M. koelense probably—Mt. Lanihuli, Oahu, 2,500-2,700 ft., April 7, 1935.

In *Freycinetia*—

16—Remains of a crustacean.

17—Remains of a non-nematocerous fly.

18—Remains of an adult nematocerous fly, etc.

19—Two mymarid wasp wings and a thorax, probably *Polynema*, remains of a spider ?.

20—Remains of a carabid larva; small carabids may be very common in *Freycinetia*.

M. koelense probably, Kaluanui Valley, Oahu, 2,000 ft., February 22, 1931.

In *Freycinetia*—

21—A small *Megalagrion* nymph.

22—A small dark mite.

Besides these, the crops and gizzards of a very considerable number of other nymphs from the above localities were either empty or else contained material—usually of a fine character—which I could not identify.

Megalagrion oahuense (Blackburn).

Agrion oahuense Blackburn, T., Ann. and Mag. Nat. Hist., (5), XIV, 1884, p. 415 (♂).

Agrion oahuense, Perkins, R. C. L., Fauna Hawaiiensis, II, Pt. I, 1899, p. 74 (♀). High mountains of Oahu.

Megalagrion oahuense is a rather large damselfly of very slender form (Plate XIX, 124 ♂).[38] The colors are somewhat dull,

[38] Compare with *M. amaurodytum* race *waianaeanum* ♂, Plate XVI, Fig. 108.

particularly in the female and consist chiefly of red, brown and pitchy black with some bronzy green on the thorax. Structurally, this species stands well apart from the others; the male is readily identified by his peculiarly shaped terminal claspers (XVII, 117), the female by the tuft of tawny hair just behind each mesostigmal plate on the fore part of the mesothorax above (Text Fig. 9). And the isolated position of *M. oahuense* among its fellow damselflies is indicated also in its habits, which are very retiring, while the early stages though passed in decidedly wet situations are not truly aquatic.

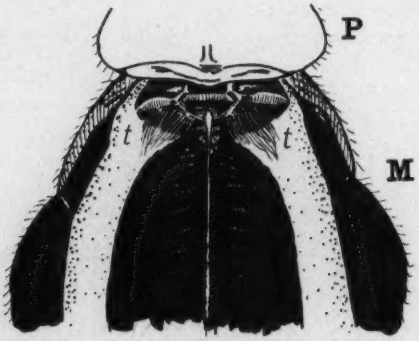


Fig. 9. *Megalagrion oahuense*, female; portion of thorax from above to show mesostigmal plate bearing posteriorly a hair tuft *tt*, on each side. P, pronotum; M, mesonotum.

Field observations on this insect were made in the Koolau Mountains just behind Honolulu, from early April 1935 into February 1936. Here it was found to range from an altitude of about 1,600 feet to far into the cloud zone of summits that rise to over 3,000 feet. During favorable weather a few individuals might be disturbed here and there along the trails where for the most part they were resting on low vegetation, darting up occasionally to capture minute flies, particularly Ceratopogonidae that occur in swarms in moist regions. And since *M. oahuense* was not observed in the vicinity of permanent water but on the fern covered ridges and upper slopes, and often indeed where the plant-dwelling *M. koelense* or *M. asteliae* damselfly occurred, a search was made among the leaf bases of the *ieie* vine and the *painiu* lily for its early stages. This search being unsuccessful, damp moss and

leafy trash were also examined, but likewise unavailingly. Then female *oahuense* were watched for egg-laying and finally, after a number of excursions to the mountains apparent oviposition among dead fern debris was observed. Several times previous to this observation however, female *oahuense* were confined in large glass jars supplied with wet moss, leaves, etc., in hopes that eggs would be laid. A few of these insects lived rather well in captivity, one surviving for 17 days. As a rule, they were fed once or twice daily, with soft portions of small Lepidoptera and of beetle larvae and pupae, the morsel being thrust up against the damselfly's mouth parts, which then often laid hold of it. A few times one or two of these captives placed the end of the body in contact with materials in the jar, but this action seemed too brief for oviposition. However, in looking over some of the trash in the jar a single damselfly egg was found. It was of a pale orange color, relatively stout and about 0.82 mm. long, being quite firmly secured for part of its length to a bit of moss. It failed to hatch.

My extensive search for the early stages of *oahuense,* eventually narrowed down the field of observation to an area hardly an acre in extent, the very head of a small canyon, leading from upper Manoa Valley and formed by the junction of a steep spur with the ridge that culminates in Mt. Olympus, elevation about 2,400 feet. This sloping hollow was perhaps 1,600 feet above sea level and here contained no water save occasionally tiny rain puddles of a very temporary nature. Its rather deforested slopes were covered with a thick tangled growth, some three feet tall, of *uluhi* or false staghorn fern (*Gleichenia linearis* (Burmann) Clark) (Text fig. 10). Here and there an *ieie* vine (*Freycinetia*) would thrust its glossy head of leaves through this cover, or an occasional tree fern (*Cibotium*) rose above it; ginger (*Zingiber zerumbet* Roscoe) mingled with fern along the bottom; almost a forest of *ti* (*Cordyline terminalis* Kunth) crowded luxuriantly at the lower end there, while such weeds as false vervain or *oi* (*Stachytarpheta dichotoma* Vahl), and the noxious thorny thimbleberry (*Rubus rosaefolius* Smith) occasionally intermingled. At the leaf bases of *Freycinetia* could be found an occasional nymph of *Megalagrion koelense,* or *asteliae,* the adults being more rarely seen. The large rather stout adults of *M. deceptor* were noted on two or three occasions, but adult *M. oahuense* were seen on most of my

numerous visits to this locality. On August 11, full 20 were observed, while on September 1, I noted at least 30. From this "peak" they became steadily less plentiful. On December 8, in a spell of sultry weather a recently emerged male was found, while on the showery morning of January 12, 1936, a female certainly not more than a day old and a well matured male were observed. On February 2, during a spell of cool weather, 4 males were noted.

Fig. 10. *Uluhi* fern (*Gleichenia linearis* (Burmann) Clark) in the mountains behind Honolulu. This cover is about 3 feet tall. The foreground has been cleared of the fern in a search for nymphs of the damselfly *Megalagrion oahuense*. Elevation about 1,500 feet.

Thus, the insect may be taken in the adult stage throughout the year.

In a letter to the writer, Dr. R. C. L. Perkins mentioned having seen *M. oahuense* adults about the dense growth of *uluhi,* and this indeed seems to be its favored habitat where the plant occurs, other ferns and plants substituting or filling in perhaps where the *uluhi* is not so abundant. My search for nymphs in the canyon head was long and arduous and resulted in the formation of paths, indentions and larger spaces in this difficult cover. While the upper portion of this fern was generally green and in a living state, beneath and largely cut off from the sunlight were browned fronds and dark stems, while yet nearer the damp ground the dead portions had so disintegrated as to form a sort of grating, or a mat reposing on the soil itself and there retaining considerable moisture.

Many times was an *M. oahuense* disturbed from its low perch near to or against the side of this *uluhi* cover; the insect would settle nearby and then sometimes in short flights descend to lower perches until it was close to the ground. Occasionally it would penetrate out of sight in this fern wall; more often however, it would dart at a tiny fly close at hand and even strike at some mite or insect on frond or stem and then settle down to eat its capture. Tiny ceratopogonid midges that breed in the wet fern trash hovered in gently shrill swarms all about this area and surely form a good part of the menu of *oahuense.* On one occasion a female *oahuense* was seen to follow a small moth until it had alighted on a fern, when it was immediately snatched off and leisurely devoured. And again, another female caught and devoured a young jumping spider (Attidae).

This damselfly is a noticeably tame insect, and time and again have I picked it off its perch by wings or abdomen. Several pairs were noted in copulo but none were ever seen in tandem.

The search for the nymph involved tearing openings through the *uluhi* cover—the sharp stiff broken fern stems making this work rather unpleasant—and the examination of wet trash. But the discovery one day of a freshly emerged adult and then of two others, a male and a female, on another day (in each case resting in or alongside the fern bank), lent encouragement to the chase. These three adults, though yet pallid and soft, were able to fly

and, having been disturbed from their perches, probably thereby lost for me the location of the exuviae from which they had issued. And very early on the afternoon of September 1, a single female was observed inserting her eggs—or attempting to do so—in *uluhi* debris, frond portions, etc., close to the ground alongside the edge of the fern wall.

These several observations clearly indicated that the nymph of *oahuense* was to be sought for among or under the moist debris that formed the lowest zone of the *uluhi* fern cover. Several loads of this fern trash were brought down to the laboratory and there examined with or without the aid of water, and in the smallest of these lots was found, on September 2, my first *oahuense* nymph, rather more than half grown. This productive debris had been gathered around the spot, close to the bed of the gulch, where the two freshly developed adults had been seen. This nymph measured nearly 12 mm. to the extremity of its short thick caudal gills. A fruitless search on September 7. Then on September 15, after an intermittent search of about 2½ hours a somewhat larger nymph nearly 14 mm. long was found on some wet muddy ground from which I had just removed the rather low *uluhi* cover. This was in the rather wide and shallow storm water channel of the gully, and on my eighth visit to the area. A number of subsequent trips yielded nothing.

These two *M. oahuense* nymphs were placed in separate glass

XIX

MEGALAGRION OAHUENSE

Explanation of Plate

124. Adult, male. Length 51.5 mm.

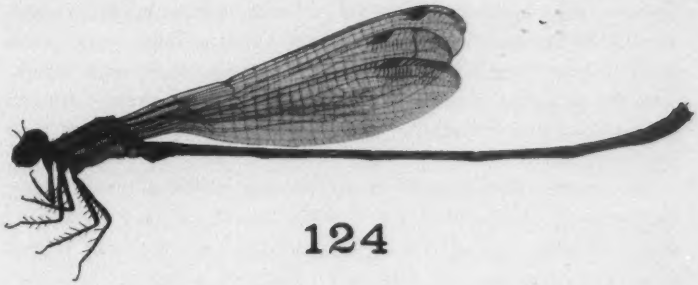
125. Nymph, female, from above; in penultimate stage. Length about 13 mm.

126. Same as Fig. 125, but from the underside.

127. Gills, median and one lateral (A) of Fig. 125; from side. Although the gills are thick and swollen, they are distinctly four-angled.

128. Labium, of Fig. 125, from the inside to show two large setae on each of the lateral lobes and two groups of small setae on the median lobe. The front margin of the median lobe is finely serrate.

Figs. 124-126, photographs by W. Twigg-Smith.



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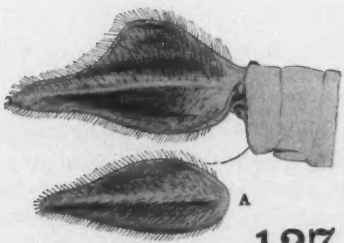

A

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Megalagrion oahuense

dishes containing wetted *uluhi* (*Gleichenia linearis*) trash in which were later introduced a number of very young sowbug Crustacea—as food. One nymph disappeared after a captivity of over a month. The second lived until December 8. During all this time it seemed not to have moulted, and to have slightly contracted rather than increased in size.

As a rule quiet, but when needs be a jerkily active creature that, earwig or scorpion-like, quickly bends forward its tail to ward off with thick gill tips any offending object there; a very indifferent wriggling swimmer when placed in water and not overfond of immersion in that element, this dull colored, roughened, almost woolly insect is indeed difficult to discover in its comparatively vast surroundings of brown soil and fine debris materials with which it blends so well. Found under very moist conditions, yet leading a terrestrial existence, the fine pale hairs on its body—in part arranged somewhat tuft-like on head and thorax, and as dorsal, subdorsal and lateral ridge-like rows on the segments of the abdomen, but above all, as an almost dense and silky covering on the three swollen tail gills—suggest an adaptation for better retaining moisture on the insect's body, even to the extent of forming a film of water, particularly about its tail end. The antennae are rather thick; 5 and 6 jointed in this, an immature specimen. Forward on the eyes is a curved row of pale spots. The general color is a sort of purplish red with a fine pale median line on part of the head and thorax, and a broader line on the abdomen. There is a whitish dorsal dash at the base of the median gill. The gills though swollen, are 4-angled, the median one most obviously so. The labium is short and broad with two setae on the lateral lobes and a small group on each side on the disc of the median lobe (XIX, 128).

The two nymphs captured were of an unkempt appearance due to the fine particles of materials collected among the hairs.

The one that survived captivity for nearly 3 months showed little inclination to feed, ignoring almost entirely the young Crustacea, pomace fly and nitidulid beetle larvae, minute millipeds, etc., some of which were forced to pass in review in close proximity to its face. Its feeding habits therefore remain unknown. There are available in the natural habitat of the nymph of *M. oahuense* a

host of small tender organisms, including copepod Crustacea and several species of nematocerous fly larvae.

The search for additional young of this damselfly will be continued, and some success may be anticipated in securing nymphs from eggs laid afield and in the laboratory. At the present writing, at least one nymph has thus been secured and although still quite small the median gill already shows a strongly arched profile.

The adult damselfly being a very low flyer thereby keeps pretty well out of the way of the large hawking dragonflies. Occasionally however, one of these insects becomes ensnared in the orb web of a spider among *uluhi* fern or other plant growth.

KEY FOR SEPARATING THE NYMPHS OF OAHUAN

MEGALAGRION

The following key for distinguishing the nymphs of Oahuan damselflies[39] is based mainly on specimens in the last stage of growth, although it will serve fairly well with younger individuals. The caudal gills will be found to vary within certain limits—as shown to some extent by the illustrations; likewise there may be variation in the development and the number of bristles or setae on the inner (superior) surface of the median and lateral lobes of the mentum. The marginal setae of the median lobe, and those along the inner eye margins are not used here; neither are the lateral carinae or ridges of the abdomen.

1. Gills large flattened leaflike, somewhat flexible, their tracheae with well marked pigmental bands and branching tree-like; marginal hairs beyond the base of the gills very fine, often more or less lacking; about 5-9 long setae on inner side of lateral lobes of mentum and at least one pair of long setae on the median lobe..... 2

   Not as above..... 3

2. Gills narrowed somewhat stem-like towards the base; spatulate; 5-6 setae on lateral lobes, and 1-3 pairs of long ones on median lobe. In mountain streams.....**M. leptodemas**

   Gills somewhat broader, hardly stem-like towards the base; at least 8 setae on lateral lobes and 4 or more pairs of long setae on the median lobe. Usually lowland forms, in reservoirs, etc...**M. xanthomelas**

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[39] Except *M. pacificum* and *deceptor* with which I am not positively familiar.

3. Gills somewhat leaflike but tending to be swollen or saccate, tender and flexible, tips slender; obviously spinose or hairy along their entire margin. Median lobe of mentum as wide as head or nearly so, one long and sometimes one quite short seta towards apex of lateral lobes; short setae on median lobe. Often under stones in streams ..... **M. nigrohamatum** (Molokai), **nigrolineatum** (Oahu)

   Gills sword or dagger-shaped, or very short and thick, nearly or quite rigid; median lobe much narrower than head; not more than 5 setae on each lateral lobe 4

4. Larger, up to 25 mm. to extremity of gills; gills rather broadly dagger-shaped, strongly serrate and bristled along margins, usually a dark pigmented area beyond the middle, the apex pale; lateral lobes of mentum more commonly with 2 rather poorly developed subapical bristles, the lower one the smaller; median lobe with some quite short setae. In streams and on dripping wet banks ..... **M. oceanicum, M. blackburni**

   Smaller, usually less than 21 mm.; head comparatively wider; gills usually not so strongly and regularly serrate, and lacking a conspicuously pigmented area beyond the middle; at least 2 well developed setae on each lateral lobe 5

5. Gills narrow dagger-like, rather finely serrate, usually dusky before the pale apex; 2 well spaced bristles on each lateral lobe, the first bristle near apex, the second bristle a little above the middle length of the lobe; partly terrestrial ..... **M. hawaiiense**

   Gills thick and short, the median one commonly variably falcate; bristles of lateral lobes usually 5; living at the leaf bases of plants in wet forests ..... **M. amaurodytum waianaeanum, M. koelense** and **M. asteliae**

   Gills thickened, densely hairy, the median one conspicuously arched dorsally for its basal half or more; bristles of lateral lobe 2, the more apical one the shorter.[40] Living among moist *uluhi* fern trash in the mountains ..... **M. oahuense**

A single nymph taken at 2,000 ft. in the Koolau Mts. yielded what appears to be a small male *deceptor*, although much resembling *hawaiiense*. The nymph is like the latter but the lateral mental lobes have each 3 instead of 2 well-spaced setae.

[40] Based on a single nymph in the penultimate stage.

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Records of Immigrant Insects for the Year 1935

By the Editor

In this issue of the Proceedings, the following new immigrant insects are recorded. Those marked with an asterisk were observed for the first time on the date mentioned. The others have been previously collected, but herein named for the first time. For details of records, etc., refer in the text to the pages given.

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Proc. Haw. Ent. Soc., IX, No. 2, April, 1936.

Host Ranges of Some Hawaiian Thrips—(Preliminary Report)

BY K. SAKIMURA

(Presented at the meeting of May 3, 1935)

The following data were collected during 1930 and 1931 while engaged in a survey of the host range of *Thrips tabaci* Lind. in Hawaii.

1. **Hercothrips femoralis** (Reuter).

Emilia sagittata	Dwarf Milo maize
Senecio hieracifolia	Orchids
Pineapple	Tomato
Egg plant	

(All records from greenhouse only)

2. **Anaphothrips swezeyi** Moulton.

Trisetum glomeratum	*Syntherisma sanguinalis*
Panicum barbinode	*Cenchrus echinatus*

3. **Taeniothrips hawaiiensis** (Morgan).

Cajanus cajan	*Acacia farnesiana*
Crotalaria juncea	*Datura stramonium*
Crotalaria saltiana	Radish
Ipomoea pentaphylla	Squash
Lantana camara	Rose
Prosopis chiliensis	Hibiscus

4. **Thrips abdominalis** Crawford.

Emilia sagittata	*Ipomoea pes-caprae*
Bidens pilosa	*Tithonia rotundiflora*
Chrysanthemum sp.	*Malva* sp.
Gaillardia pulchella	

5. **Thrips panicus** Moulton.

Syntherisma sanguinalis	*Paspalum conjugatum*
Eleusine indica	Pineapple
Cenchrus echinatus	*Emilia sagittata*

6. **Dolerothrips** sp.

Cenchrus echinatus
Panicum barbinode
Pineapple
Emilia sagittata
Gaillardia pulchella
Mirabilis jalapa

7. **Aleurodothrips** sp.

Pineapple

8. **Haplothrips gowdeyi** (Frank.).

Erigeron canadensis
Ageratum conyzoides
Bidens pilosa
Emilia sagittata
Crotalaria juncea
Crotalaria saltiana
Leucaena glauca
Phaseolus lathyroides
Cassia mimosoides
Waltheria americana
Stachys arvensis
Lantana camara
Euphorbia geniculata
Verbena bonariensis
Chaetochloa verticillata
Syntherisma sanguinalis
Panicum barbinode
Cenchrus echinatus
Prosopis chiliensis
Acacia farnesiana
Stachytarpheta dichotoma
Mirabilis jalapa
Chenopodium album
Verbesina encelioides
Amaranthus retroflexus
Ipomoea tuberculata
Ipomoea pentaphylla
Tephrosia piscatoria
Valota insularis
Cucumis dipsaceus
Cyperus rotundus
Richardsonia scabra
Trisetum glomeratum
Hymenocallis declinata
Portulaca oleracea
Gaillardia pulchella
Isotoma longiflora
Tithonia rotundiflora
Raphanus sativus
Alfalfa
Onion

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Panicum barbinode
Pineapple
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Onion

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